School of Educ. Lib.

BULLETIN of the
ATOMIC SCIENTISTS . . .

VOL. 2 OCTOBER 1, 1946 Nos. 7 and 8

Editorial:
Deadlock or Slow Progress? . . .

The very slow-moving deliberations of the UN Atomic Energy Commission has resulted in a widespread feeling of anxiety over this tendency to drift. Since the possibility of influencing the official Soviet attitude by contact with Russian scientists or appeal to public opinion in the Soviet Union appears, at best, very remote, criticism naturally turns to our own policy. It is asked whether the Baruch plan was the best proposal we could have made to make international control of atomic energy acceptable to the Russians, and whether it was presented in the proper spirit to ensure friendly reception. Criticism along these lines has been voiced here and abroad, particularly eloquently in Secretary Wallace's letter to President Truman on July 23.

Wallace's main objection was that the American proposal envisaged, as the first step, the disclosure by all nations of their resources, but that the timing of further steps, including the release of American scientific and technical information, cessation of bomb production and destruction of existing bombs, was left to the discretion of the United States. Wallace suggested that the only way to obtain Russian cooperation is by agreeing on a complete time schedule right from the beginning.

A second point criticized by Wallace (and others) was the suggested abolition of veto power in atomic energy matters—a proposal which arouses violent Soviet opposition and which Wallace termed "completely irrelevant."

Lately, a third objection to Baruch's plan has been attributed to the Russians—their alleged apprehension that the Atomic Development Authority, by exercising control over what might become an important source of industrial power, can serve as a means to subject the socialist economy of the USSR to domination by the capitalist economies of the West.

* * *

As pointed out in the statement of Mr. Baruch printed in this Bulletin, and was conceded by Wallace, the first criticism is not supported by the official text of American statements. It is deplorable that such misunderstandings should arise. We cannot afford to split American public opinion supporting international control along partisan political lines. The American ADA-plan undoubtedly constitutes a radical departure from the traditional principles of national sovereignty and private enterprise. Nevertheless, it has found supporters not only in internationalist or socialistically-inclined groups, but also in conservative circles. Not so long ago, those who proposed international control were described as radicals whose true aim is to "give the secret to the Russians." Now, we hear suspicions that international control is a tricky device to establish the ascendancy of American capitalism over the whole world. We prefer to assume that whoever attempts to think through the facts and implications of atomic energy—and honest thinking is not the prerogative of a single political or economic group—inevitably arrives at the conclusion that nothing short of effective international control can provide security to this or any other country. We need wholehearted cooperation of all who have reached this conclusion. It will be difficult enough to achieve the establishment of international control even by a concerted effort of the whole American nation; this aim will never be reached by forces of a partisan minority alone.

* * *

Appealing for national unity in the fight for international control does not mean that we suggest that the world be confronted with an uncompromising support of the American plan. On the contrary, we should make it clear that the only thing on which no bargaining is possible, is the principle of effective international control itself. For the rest, suggestions for the amendment to the American plan, or even entirely new plans, must be welcomed. The American delegation can point out that such was its official attitude from the very beginning. Nevertheless, it seems true that the opposite impression has arisen even in some friendly delegations. The attitude of a part of the American press may have contributed to this impression. It is to be hoped that the statement just issued by Mr. Baruch will help to dispel these misapprehensions.

That a change of veto provisions of the Charter, however desirable, is not an essential part of a settlement of the atomic energy problem, was argued in this place before (Bulletin, Vo. 2, No. 1-2). The principle of international ownership or managerial control of "dangerous" activities (as opposed to control through inspection of national developments) is one which we are loath to give up. It gave to the Lilienthal board report its imaginative and inspiring quality. We hope that it can be implemented in such a way as to allay Soviet misgivings that it will endanger the economic system of the USSR. (After all, this program can equally well be considered as a threat to private enterprise throughout the world!) But if the Soviet leaders are afraid of the ADA and prefer to discuss inspection as means of ensuring atomic disarmament, we must be prepared to negotiate on this basis too. We may recall that it took us six months or more to progress from the first tentative inspection plans to the much more ambi-

(Continued on page 29)

IN THIS ISSUE

From the Letter to the President — H. A. Wallace

Memorandum to the President — B. M. Baruch

Report of the UN Scientific and Technical Subcommittee

How Can Atomic Energy Be Controlled — D. E. Lilienthal

Official Report on Biological Warfare — G. W. Merck

Atomic Bomb and Prevention of War — B. Russell

Medical Uses of Atomic Energy — C. P. Rhoads

Pattern of an Armaments Race — G. Bateson

Security Through the Sacrifice of Sovereignty — C. I. Barnard

from the Letter to the President . . .

(July 23, 1946) . . . . . Henry A. Wallace

The letter which former Sec'y of Commerce Wallace addressed to President Truman on July 23 and which was published on Sept. 17, is an eloquent statement of Mr. Wallace's point of view on American foreign policy. We reprint that portion of the letter devoted to the question of international control of Atomic energy because of its importance as the first criticism of the Baruch plan to come from an authoritative American source. Mr. Wallace's remarks on this subject deserve close consideration, independently of general approval or disapproval of the remainder of his letter.

As we go to press Mr. Baruch has published a detailed answer to Mr. Wallace's criticisms. This statement is printed on pages 4 and 5 of this issue.

There can be no doubt that the American people want and expect that their leaders will work for an enduring peace. But the people must necessarily leave to their leaders the specific ways and means to this objective. I think that at the moment the people feel that the outlook for the elimination of war is dark, that other nations are wilfully obstructing American efforts to achieve a permanent peace.

How do American actions since V-J day appear to other nations? I mean by actions, the concrete things like $13,000,000,000 for the War and Navy Departments, the Bikini tests of the atomic bomb and continued production of bombs, the plan to arm Latin America with our weapons, production of B-29's and planned production of B-36's and the effort to secure air bases spread over half the globe from which the other half of the globe can be bombed. I cannot but feel that these actions must make it look to the rest of the world as if we were only paying lip service to peace at the conference table.

These facts rather make it appear either (1) that we are preparing ourselves to win the war which we regard as inevitable or (2) that we are trying to build up a predominance of force to intimidate the rest of mankind. How would it look to us if Russia had the atomic bomb and we did not, if Russia had 10,000-mile bombers and air bases within 1,000 miles of our coast lines and we did not?

Some of the military men and self-styled "realists" are saying: "What's wrong with trying to build up a predominance of force. The only way to preserve peace is for this country to be so well armed that no one will dare attack us. We know that America will never start a war."

The flaw in this policy is simply that it will not work. In a world of atomic bombs and other revolutionary weapons, such as radioactive poison gases and biological warfare, a peace maintained by a predominance of force is no longer possible.

Why is this so? The reasons are clear.

First, atomic warfare is cheap and easy compared with old-fashioned war. Within a very few years several countries can have atomic bombs and other atomic weapons. Compared with the cost of large armies and the manufacture of old-fashioned weapons, atomic bombs cost very little and require only relatively small part of a nation's production plant and labor force.

Second, so far as winning a war is concerned, having more bombs — even many more bombs—than the other fellow, is no longer a decisive advantage. If another nation had enough bombs to eliminate all our principal cities and our heavy industry, it wouldn't help us very much if we had 10 times as many bombs as we needed to do the same to them.

Third, the most important, the very fact that several nations have atomic bombs, will inevitably result in a neurotic, fear-ridden, itching-trigger psychology in all the peoples of the world, and because of our wealth and vulnerability we would be among the most seriously affected.

Atomic war will not require vast and time-consuming preparations, the mobilization of large armies, the conversion of a large proportion of a country's industrial plants to the manufacture of weapons. In a world armed with atomic weapons, some incident will lead to the use of those weapons.

There is a school of military thinking which recognizes these facts, recognizes that when several nations have atomic bombs, a war which will destroy modern civilization will result and that no nation or combination of nations can win such a war. This school of thought, therefore, advocates a "preventive war", an attack on Russia now before Russia has atomic bombs.

This scheme is not only immoral but stupid. If we should attempt to destroy all the principal cities and her heavy industry, we might well succeed. But the immediate counter-measure which such an attack would call forth is the prompt occupation of all continental Europe by the Red Army. Would we be prepared to destroy the cities of all Europe in trying to finish what we had started?

This idea is so contrary to all the basic instincts and principles of the American people that any such action would be possible only under a dictatorship at home. Thus the "predominance of force" idea, and the notion of a "defensive attack" are both unworkable.

The only solution is the one which you have so wisely advanced and which forms the basis of the Moscow statement on atomic energy. That solution consists of mutual trust and confidence among nations, atomic disarmament and an effective system of enforcing that disarmament.

There is however, a fatal defect in the Moscow statement, in the Acheson report and in the American plan recently presented to the United Nations Atomic Energy Commission.

That defect is the scheme, as it is generally understood, of arriving at international agreements by "many stages", of requiring other nations to enter into binding commitments not to conduct research into the military uses of atomic energy and to disclose their uranium and thorium resources while the United States retains the right to withhold its technical knowledge of atomic energy until the international control and inspection system is working to our satisfaction.

In other words, we are telling the Russians that if they are "good boys" we may eventually turn over our knowledge of atomic energy to them and to the other nations. But there is no objective standard of what will qualify them as being "good" nor any specified time for sharing the knowledge.

Is it any wonder that the Russians did not show any great enthusiasm for our plan? Would we have been enthusiastic if the Russians had a monopoly of atomic energy and offered to share the information with us at some indefinite time in the future at their discretion if we agreed now not to try to make a bomb and give them information on our secret resources of uranium and thorium?

I think we would react as the Russians appear to have done. We would have put up counter-proposals for the record, but our real effort would go into trying to make a bomb so that our bargaining position would be equalized. That is the essense of the Russian position, which is very clearly stated in the Pravda article of June 24, 1946.

It is perfectly clear that the "step-by-step plan" in any such one-sided form is not workable. The entire agreement will have to be worked out and wrapped up in a single package. This may involve certain steps or stages, but the timing of such steps must be agreed to in the initial master treaty. Realistically, Russia has two cards which she can use in negotiating with us:

1. Our lack of information on the state of her scientific and technical progress on atomic energy, and

2. Our ignorance of her uranium and thorium resources.

These cards are nothing like as powerful as our cards—a stock-pile of bombs, manufacturing plants in actual production, B-29s and B-36s and our bases covering half the globe. Yet we are in effect asking her to reveal her only two cards immediately—telling her that after we have seen her cards we will decide whether we want to continue to play the game.

Insistence on our part that the game must be played our way will only lead to a deadlock. The Russians will redouble their efforts to manufacture bombs, and they may also decide to expand their "security zone" in a serious way.

Up to now, despite all our outcries against it, their efforts to develop a security zone in Eastern Europe and in the Middle East are small change from the point of view of military power as compared with our air bases in Greenland, Okinawa and many other places thousands of miles from our shores.

We may feel very self-righteous if we refuse to budge on our plan and the Russians refuse to accept it, but that means only one thing—the atomic armament race is on in deadly earnest.

I am convinced therefore that if we are to achieve our hopes of negotiating a treaty which will result in effective international atomic disarmaments, we must abandon the impractical form of the "step-by-step" idea which was presented to the United Nations atomic energy commission.

We must be prepared to reach an agreement which will commit us to disclosing information and destroying our bombs at a specified time or in terms of specified actions by other countries, rather than at our unfettered discretion.

If we are willing to negotiate on this basis, I believe the Russians will also negotiate seriously with a view to reaching an agreement.

There can be, of course, no absolute assurance the Russians will finally agree to a workable plan if we adopt this view. They may prefer to stall until they also have bombs and can negotiate on a more equal basis, not realizing the danger to themselves as well as the rest of the world in a situation in which several nations have atomic bombs.

But we must make the effort to head off the atomic bomb race. We have everything to gain by doing so, and do not give up anything by adopting this policy as the fundamental basis for our negotiation.

During the transition period toward full-scale international control, we retain our technical know-how, and the only existing production plants for fissionable materials and bombs remain within our borders.

The Russian counter-proposal itself is an indication that they may be willing to negotiate seriously if we are. In some respects their counter-proposal goes even further than our plan and is in agreement with the basic principles of our plan, which is to make violations of the proposed treaty a national and international crime for which individuals can be punished.

It will have been noted that in the preceding discussion I have not mentioned the question of the so-called "veto". I have not done so because the veto issue is completely irrevelant, because the proposal to "abolish the veto", which means something in the general activities of the Security Council, has no meaning with respect to a treaty on atomic energy.

If we sign a treaty with other nations, we will all have agreed to certain things. Until we arrive at such a treaty, we as well as the other major powers will have the power to veto. Once the treaty is ratified, however, the question of veto becomes meaningless.

If any nation violates the treaty provision, say of permitting inspection of suspected illegal bomb-making activities, what action is there that can be vetoed? As in the case of any other treaty violations the r e m a i n i n g signatory nations are free to take what action they feel is necessary, including the ultimate step of declaring war.

We should try to get an honest answer to the question of what the factors are which cause Russia to distrust us, in addition to the question of what factors lead us to distrust Russia. I am not sure that we have as a nation or an administration found an adequate answer to certain questions, although we have recognized that both questions are of critical importance.

We should not pursue further the question of the veto in connection with atomic energy, a question which is irrevalent and should never have been raised. We should be prepared to negotiate a treaty which will establish a definite sequence of events for the establishment of international control and development of atomic energy.

This, I believe, is the most important single question and the one on which the present trend is definitely toward deadlock rather than ultimate agreement.

Mr. Wallace returned to the atomic energy question in the summary at the end of his letter:

This proposal admittedly calls for a shift in some of our thinking about international matters. It is imperative that we make this shift. We have little time to lose. Our postwar actions have not yet been adjusted to the lessons to be gained from experience of Allied cooperation during the war and the facts of the atomic age.

It is certainly desirable that, as far as possible, we achieve unity on the home front with respect to our international relations; but unity on the basis of building up conflict abroad would prove to be not only unsound but disastrous.

I think there is some reason to fear that in our earnest efforts to achieve bi-partisan unity in this country we may have given way too much to isolationism masquerading as though realism in international affairs.

The real test lies in the achievement of international unity. It will be fruitless to continue to seek solutions for the many specific problems that face us in the making of the peace and in the establishment of an enduring international order without first achieving an atmosphere of mutual trust and confidence.

The task admittedly is not an easy one. There is no question, as the Secretary of State has indicated, that negotiations with the Russians are difficult because of cultural differences, their traditional isolationism and their insistance on a visible quid pro quo in all agreements.

But the task is not an insuperable one if we take into account that to other nations our foreign policy consists not only of the principles that we advocate, but of the sections we take.

Fundamentally, this comes down to the point discussed earlier in this letter, that even our own security, in the sense that we have known it in the past, cannot be preserved by military means in a world armed with atomic weapons.

The only type of security which can be maintained by our own military force is the type described by a military man before the Senate Atomic Energy Commission—a security against invasion after all our cities and perhaps 40,000,000 of our city population have been destroyed by atomic weapons.

That is the best that "security" on the basis of armaments has to offer us. It is not the kind of security that our people and the people of the other United Nations are striving for.

I think that progressive leadership along the lines suggested above would represent and best serve the interests of the large majority of our people, would reassert the forward looking position of the Democratic Party in international affairs, and, finally, would arrest the new trend towards isolationism and a disastrous atomic world war.

Memorandum to the President

(September 24, 1946) . . . . . Bernard M. Baruch

Secretary Wallace's letter of July 23, 1946, on foreign policy includes a discussion of the international control of atomic energy. The United States Delegation to the United Nations Atomic Energy Commission had no knowledge of this letter prior to its appearance in the press on September 18. The letter contains a number of statements purporting to describe the United States proposals for atomic energy control which are directly at variance with the facts as repeatedly stated in widely published documents well before the time when the letter was written. There are also misunderstandings as to the proposals made by the Soviet Union.

This memorandum is intended simply to point out the major errors of fact with a view to setting the record straight. It does not attempt to cover every detail or to restate the entire United States position. Secretary Wallace's letter also contains some mistaken conclusions, which were the inevitable result of the errors of fact. In this field, as in all others, sound conclusions can be based only on the facts.

The misstatements in Secretary Wallace's letter may be summarized under five headings. They are:

(1) the method of determining the stages of transition to the ultimate control plan,
(2) the content and sequence of these transition stages,
(3) the proposed limitation on the Great Power veto,
(4) the nature of the Soviet proposal,
(5) the refusal by the United States to depart from the principles of its plan.

1. METHOD OF DETERMINING STAGES OF TRANSITION

(a) Secretary Wallace's Statements

"There is, however, a fatal defect in the Moscow statement, in the Acheson **report and in the American plan re**cently presented to the United Nations Atomic Energy Commission. **That defect is the scheme, as it is** generally understood, of arriving at international agreements by 'many stages', of requiring other nations to enter into binding commitments not to conduct research into the military uses of atomic energy and to disclose their uranium and thorium resources while the United States retains the right to withhold its technical knowledge of atomic energy until the international control and inspection system is working to our satisfaction."

Secretary Wallace repeatedly suggests that under the United States plan, both the timing of the transition and the sequence of steps would be left to the sole discretion of the United States. Thus he says "there is no objective standard of what will qualify them (the Russians) as being 'good' nor any specified time for sharing our knowledge." And again, he refers to offering to share the information "at some indefinite time in the future" at our discretion.

In place of the United States proposal, as he conceives it, Secretary Wallace calls for a clear definition of the transition stages to full international control, negotiated in advance as part of the treaty. Thus he says:

"It is perfectly clear that the 'step-by-step' plan in any such one-sided form is not workable. The entire agreement will have to be worked out and wrapped up in a single package. This may involve certain steps or stages, but the timing of such steps must be agreed to in the initial master treaty."

He repeats this thought later in the following paragraph:

"I am convinced therefore that if we are to achieve our hopes of negotiating a treaty which will result in effective international atomic disarmaments we must abandon the impractical form of the 'step-by-step' idea which was presented to the United Nations Atomic Energy Commission. We must be prepared to reach an agreement which will commit us to disclosing information and destroying our bombs at a specified time or in terms of specified action by other countries, rather than at our unfettered discretion. If we are willing to negotiate on this basis, I believe the Russians will also negotiate seriously with a view to reaching an agreement."

(b) The Facts

Secretary Wallace's statements reflect complete ignorance of the United States position. Prior to July 23, we had made clear in three widely published documents that the United States proposal contemplates the very method of determining the stages of transition which Mr. Wallace endorses.

In the first paragraph quoted above, Mr. Wallace appears to condemn the whole idea of approaching the atomic energy problem by stages. It should be noted that this idea is not a unilateral proposal of the United States. Long before its presentation in the Acheson-Lilienthal Report and in the official statement of the United States position to the Atomic Energy Commission, it had been specifically endorsed in the Moscow Resolution, signed last December by the Soviet Union, the United Kingdom, and ourselves, and again in January by the unanimous vote of the United Nations General Assembly .

At a later point, Secretary Wallace recognizes the need for "certain steps or stages," but objects to the allegedly "one-sided form" in which these stages would proceed and the alleged proposal for timing the stages at the sole discretion of the United States. He advocates instead that the stages "be worked out and wrapped up in a single package," agreed to in advance "in the initial master treaty."

This is exactly the United States proposal on this point, as the following quotations show. Thus Mr. Wallace is arguing vigorously for the official United States position, while treating it as if our proposal had been entirely different.

In the original presentation of the United States proposal at the first meeting of the United Nations Atomic Energy Commission on June 14, I said:

"**Progress by Stages.** A primary step in the creation of the system of control is the setting forth, in comprehensive terms, of the functions, responsibilities, powers, and limitations of the Authority. Once a charter for the Authority has been adopted, the Authority and the system of control for which it will be responsible will require time to become fully organized and effective. The plan of control will, therefore, have to come into effect in successive stages. **Those should be specifically fixed in the charter or means should be otherwise set forth in the charter for transitions from one stage to another, as contemplated in the resolution of the United Nations Assembly which created this Commission.**"

(underscoring supplied)

Memorandum No. 1, submitted to the Commission by the United States Representative on July 2 stated:

"The treaty should contain provisions governing the sequence and timing of the steps in the transition from the present conditions to the conditions which will prevail once the Authority is in effective control of atomic energy."

And again on July 5, in Memorandum No. 2, the United States Representative stated:

"Obviously, the controls outlined in this memorandum cannot spring into existence full-grown and complete upon the legal establishment of the Authority. The process of putting them into effect will necessarily extend over a considerable period of time. It will have to be done by stages provided in the treaty or charter and according to pre-arranged schedules based on sound and logical sequence leading to full and effective establishment of all controls."

We have carefully examined the record in an effort to find the source of Secretary Wallace's complete misunderstanding of the United States position on the method of determining the transition stages. The

record contains nothing to support his view. Neither the Soviet delegate nor any other representative on the Atomic Energy Commission has interpreted the United States proposals as Mr. Wallace has.

2. CONTENT AND SEQUENCE OF TRANSITION STAGES

(a) Secretary Wallace's Statements

As indicated above, Secretary Wallace's letter states that the U. S. proposal contains the

> "fatal defect . . . of requiring other nations to enter into binding commitments not to conduct research into the military uses of atomic energy and to disclose their uranium and thorium resources while the United States retains the right to withhold its technical knowledge of atomic energy until the international control and inspection system is working to our satisfaction."

At a later point, he implies that our proposal would require that the Soviet Union agree now not to try to make a bomb and give us information on their secret resources of uranium and thorium, while we maintain for an indefinite period and at our own discretion the United States monopoly of atomic energy.

(b) The Facts

There is no foundation in the record for Secretary Wallace's description of the United States proposals regarding the nature and sequence of the transition stages. Thus far, no specific proposal has been made to the Atomic Energy Commission on the content and sequence of the transition stages, although a memorandum covering this point has been promised for submission at the appropriate time. The delegation has felt it futile to make detailed proposals on this point until there is some reasonable prospect of basic agreement on the broad principles of the plan—control through an international authority responsible for the operation of all dangerous activities and supervision of other activities in the field of atomic energy, supplemented by a system of inspection and machinery for swift punishment of violations. It is hardly possible to discuss the details of the transition until general agreement is in sight on the nature of the goal toward which the transition is to lead.

It has always been recognized that the precise content, sequence and timing of the transition would be the subject of detailed negotiation since the process of transition involves a shift from the present position of the United States to a position of equality in the field of atomic energy among all nations participating in the plan .

It should be obvious that in any treaty which might be negotiated, the same obligations would be assumed by all countries alike. We have not asked others to refrain from research on the military use of atomic energy and would not ask this unless we were prepared to cease such research ourselves. We have not asked others to disclose their own material resources and would not do so unless we were prepared to disclose our own.

3. MODIFICATION OF THE GREAT POWER VETO

(a) Secretary Wallace's Statements

Secretary Wallace's letter states that:

> "the veto issue is completely irrelevant, because the proposal to 'abolish the veto', which means something in the general activities of the Security Council, has no meaning with respect to a treaty on atomic energy. If we sign a treaty with other nations, we will all have agreed to do certain things. Until we arrive at such a treaty, we as well as the other major powers will have the power to veto. Once the treaty is ratified, however, the question of veto becomes meaningless. If any nation violates the treaty provision, say of permitting inspection of suspected illegal bomb-making activities, what action is there that can be vetoed? As in the case of any other treaty violations, the remaining signatory nations are free to take what action they feel is necessary, including the ultimate step of declaring war."

(b) The Facts

The statement on the question of the veto in my opening address to the Commission on June 14 was as follows:

> "It would be a deception, to which I am unwilling to lend myself, were I not to say to you and to our peoples, that the matter of punishment lies at the very heart of our present security system. It might as well be admitted, here and now, that the subject goes straight to the veto power contained in the Charter of the United Nations so far as it relates to the field of atomic energy. The Charter permits penalization only by concurrence of each of the five great Powers; the Soviet Union, the United Kingdom, China, France and the United States.
>
> "I want to make very plain that I am concerned here with the veto power only as it affects this particular problem. There must be no veto to protect those who violate their solemn agreements not to develop or use atomic energy for destructive purposes."

This statement was elaborated in Memorandum No. 3, submitted to the Commission by the U. S. Representative on July 12 and widely published in the press. We said at that time:

> "The controls established by the treaty would be wholly ineffectual if, in any such situations, to be defined in the treaty, the enforcement of security provisions could be prevented by the vote of a state which has signed the treaty. Any other conception would render the whole principle of veto ridiculous. It is intended to be an instrument for the protection of nations, not a shield behind which deception and criminal acts can be performed with impunity. This in no way impairs the doctrine of unanimity. No state need be an unwilling party to the treaty. But every state which freely and willingly becomes a party to the treaty, by this act, solemnly and firmly binds itself to abide by its undertakings. S u c h undertakings would become illusory, if the guarantee against their breach resided solely in the conscience of the one who commits the breach.
>
> "Voluntary relinquishment of the veto on questions relating to a specific weapon, previously outlawed by unanimous agreement because of its uniquely destructive character, in no wise involves any compromise of the principle of unanimity of action as applied to general problems or to particular situations not foreseeable and therefore not susceptible to advance unanimous agreement."

There is of course no difference of opinion as to Secretary Wallace's statement that until we arrive at a treaty, not only the major powers but all nations will have an effective veto over any proposals. But our plan has never taken issue with this kind of veto. Once the treaty has been ratified, the veto becomes highly relevant. It should not then be available as a possible means of protecting wrong-doers from punishment called for by the treaty itself. Nor could the Atomic Development Authority function effectively unless the veto were removed as a possible hindrance to its day-to-day administrative operations.

In answer to Secretary Wallace's specific question, the action which might be vetoed is a proposal to punish a violation of the treaty. Thus, the U. S. proposal is designed to extend as far as possible the domain of effective international law in support of peace by defining the various classes of crimes, providing for judicial determination of guilt, and setting up machinery for carrying out appropriate punishments. This proposal is in sharp contrast with the assumption that the only possible sanction against international crimes is resort to the ultimate political measure of war—an assumption seemingly made by Mr. Wallace. Even if resort to war should prove necessary as a punishment, this action should not be a mere series of unilateral steps by the nations who "are free to take what action they feel is necessary," as Mr. Wallace says, but should rather be united action pursuant to a recognized international agreement.

4. NATURE OF THE SOVIET PROPOSAL

(a) Secretary Wallace's Statements

Secretary Wallace's letter states:

> "The Russian counter-proposal itself is an indication that they may be willing to negotiate seriously if we are. In some respects their counter-proposal goes even further than our plan and is in agreement with the basic principles of our plan, which is to make violations of the proposed treaty a national and international crime for which individuals can be punished."

(Continued on page 31)

The Scientific and Technical Aspects of Atomic Energy Control . . . . . *A First Report*

. . . by the Scientific and Technical Committee of the UN Atomic Energy Commission

Letter of Transmittal:

To the Chairman of Committee 2:

Herewith is presented to Committee 2 a report from the Scientific and Technical Committee entitled "A FIRST REPORT ON THE SCIENTIFIC AND TECHNICAL ASPECTS OF THE PROBLEM OF CONTROL." This report was prepared in response to a request from Committee 2 made on 31 July 1946, that the Scientific and Technical Committee present a report on the question of whether effective control of atomic energy is possible, together with an indication of the methods by which the Scientific and Technical Committee considers that effective control can be achieved.

The report being presented deals with the scientific and technical features of atomic energy and their bearing on the problem of control. The scientific information included is non-secret and has previously appeared in published material. Our discussions were carried on in an amicable spirit, and there is unanimous agreement on the content of our report. I will not try to summarize here the conclusions of the report, since this has already been done in its last chapter.

Our Committee has discussed the possible release of the report for publication and has concluded that this decision should be made by Committee 2, inasmuch as the report was prepared for its use. However, we see no objection to the release of the report if this course of action should appear desirable.

We express our sincere hope that the report will help the Members of Committee 2 in clarifying their thought and in providing a useful basis for their discussions.

Professor H. A. Kramers
Chairman, Scientific and Technical
Committee of the Working Committee

27 September 1946
Lake Success, Long Island

TABLE OF CONTENTS

INTRODUCTION
CHAPTER I **The Production of Nuclear Fuels**
- Chain Reactions
- Raw Materials
- Processes for the Separation of U-235
- Processes for the Production of Plutonium
- Scale of the Installations for Producing Nuclear Fuels
- The Production of Uranium-233
- Summary

CHAPTER II **Utilization of Nuclear Fuels**
- Power
- Radiations
- Radioactive Isotopes
- Atomic Bomb
- Estimates of the Amount of Power or the Number of Bombs Available
- Summary

CHAPTER III **Peaceful Uses of Atomic Energy and Their Bearing on Control**
- Introduction
- Mining Operations
- Extraction from ore-concentrates and production of uranium and thorium compounds
- Production of metal and preparation for insertion of reactors
- Production of nuclear fuels
- Remarks on operation of secondary reactors
- Seizure of Installations

CHAPTER IV **Clandestine Activities**
CHAPTER V **Future Developments**
CHAPTER VI **Summary and Conclusions**
APPENDIX I Pictorial Chart—The Processes Using Uranium to Produce Atomic Energy
APPENDIX 2 Atomic Energy Flow Chart
APPENDIX 3 Some Relevant Data on Cost and Size of the U. S. Atomic Bomb Project

INTRODUCTION:

Nuclear physics was already a well-developed science when uranium fission was discovered in January 1939. Numerous nuclear transformations, some of them spontaneous, others induced artificially in the laboratory, were recognized as such and understood in considerable detail. It was known that nuclear energy was often set free in such transformations. Against this background, the discovery of fission was an interesting scientific event that added one more type of transformation which eventually found its natural place within the scientific picture.

But in the world of practical affairs, nuclear fission soon proved to be a discovery of the greatest consequence. Indeed, fission made possible a self-propagating release of enormous quantities of nuclear energy by means of a self-sustaining chain reaction. The first application was to mass destruction on a staggering scale. But, at the same time, the way was opened to a new era of industrial and scientific achievement.

On 31 July 1946, Committee 2 made the suggestion "that the Scientific and Technical Committee present a report on the question of whether effective control of atomic energy is possible, together with an indication of the methods by which the Scientific and Technical Committee considers that effective control can be achieved." At the beginning of our discussion, it was realized that a broad exploration of the technically possible methods of controlling atomic energy to ensure against its use as a weapon would inevitably lead us to the consideration of problems of a non-technical or political nature, which would have to be taken into account in a system of control. Since political matters are wholly within the jurisdiction of other committees of the Atomic Energy Commission, it was decided to limit ourselves strictly to the scientific and technical aspects of the question.

International negotiations may lead in the future to definite political agreements, which would determine upon a system of control. In preparing this report, we have not made any suggestions as to the nature of such a possible future control system. The report is intended rather to draw attention to the scientific and technical facts which have to be considered in devising any system of control.

In approaching our task, we have constantly kept in mind that the problem before the United Nations Atomic Energy Commission is not solely the question of what to do about a frightful weapon, but rather the entire problem of what use shall be made of a discovery so great that its consequences will affect the future of human society.

Broadly speaking our report falls into the two following parts:

First, we present the basic scientific and technical facts governing the domain of atomic energy and show that the activities leading to peaceful and destructive ends in this domain are so intimately interrelated as to be almost inseparable (Chapters I and II).

Secondly, we analyze the principal activities which will be carried on in the peaceful use of atomic energy, and point out the dangers which will exist if effective safeguards are not established against the use of atomic energy for destructive ends (Chapters III and IV).

Our Committee has of necessity dealt with limited information, all of which is non-secret and has been previously published. Two categories of information have been available, that contained in the pre-war scientific literature and that released after the bombing of Hiroshima.* Much of the information in the latter category has not been given in full nor have all the scientific statements been confirmed by full description of experimental procedures, as is usual in scientific publication. It is equally true, however, that no scientific arguments would lead one to doubt the essential accuracy of this information. It represents an orderly extension of the pre-war science of nuclear physics, and there are no apparent inconsistencies with this pre-existing body of scientific fact.

There exists a possibility that the information with which the Committee has dealt may be incomplete in another sense, namely, that major discoveries, as distinguished from technological developments, may have been made somewhere in the world but not disclosed. Such discoveries, as well as any which may be made within the next few years, might well affect some aspects of the problem of control in a significant way. Logically such a possibility cannot be excluded; on the other hand there are scientific grounds for believing that discoveries unknown to us, which might seriously invalidate our analysis of the technical aspects of control, are improbable.

However that may be, this report is based on the information available to us, and we believe that the statements contained in it are relevant and significant for the problem of control, provided no major discoveries which would fundamentally affect the field of atomic energy are made or have been made.

Chapter V deals with the relation of the possibility of future discoveries and inventions to the problem of control. Chapter VI summarizes our main conclusions.

*The main body of information is contained in the well-known report by H. D. Smyth, entitled "Atomic Energy for Military Purposes," 1945. Additional information is contained in "A Report on the International Control of Atomic Energy" prepared for the United States' Secretary of State's Committee on Atomic Energy, 1946 (Lilienthal Board Report), and in the Press Release of the United States Department of State, 9 April 1946. Articles and announcements have also been published in the Physical Review and in other scientific journals. Useful summaries will be found in the two volumes of "Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Member," dated 14 June 1946 and 10 July 1946.

CHAPTER I

THE PRODUCTION OF NUCLEAR FUELS

CHAIN REACTIONS

Atomic energy in quantities useful for peace or war comes only from a nuclear chain reaction, which, like fire, is self-propagating and releases energy in proportion to the nuclear fuel consumed. Only one material found in nature in appreciable quantities has the property of "nuclear inflammability," though two other nuclear fuels can be created through the "burning" of the naturally occurring one.* The nuclear fuel provided by nature is uranium-235, one of the isotopes in naturally-occurring uranium, but present only in the proportion of one part in one hundred and forty. At this dilution the U-235 can be burned only under the very special circumstances achieved in a structure called a primary reactor (or "pile"). Otherwise, the U-235 must be partly or completely separated from the more abundant U-238. This process of isotope separation is exceedingly difficult and requires large and elaborate installations.

Two new materials (plutonium-239 or uranium-233) can be formed from U-238 or thorium in nuclear fires burning U-235. They can be isolated by chemical methods more easily than isotopes can be separated, and will serve as nuclear fuels as well as U-235.

Thus there are three materials (U-235, Pu-239, and U-233) from which nuclear energy can be obtained by a chain reaction. The reaction may be used to deliver energy at a steady rate by incorporating the fuel materials into a reactor, a lattice structure big enough to confine and utilize the neutrons which propagate the reaction from atom to atom. Controlled burning is achieved by inserting materials to absorb enough of the neutrons to prevent a run-away explosion, but not so many as to quench the reaction.

The same fuel materials may be burned explosively in an atomic bomb. Again, the amount of material must be large enough to trap and use the neutrons. The violence of the explosion depends also on the rate of burning, so materials that absorb the neutrons must be carefully excluded.

Whereas concentrated nuclear fuel is required for bombs, a less concentrated material is sufficient for peaceful applications. This has led to the suggestion† that material be added which may make the fuel less suitable for bomb production, while maintaining its suitability for use in a controlled reactor. Such materials, which are called "denaturants," must be chosen so that they are extremely difficult to remove from the fuel material proper.

RAW MATERIALS

All the manifold applications of atomic energy depend on uranium and thorium as primary raw materials. It will be useful to trace the procurement of nuclear fuels from these raw materials. The pictorial chart (Appendix 1) and the flow chart (Appendix 2) indicate the principal stages and operations in processing uranium.

The mining and extraction of uranium ore and thorium ore is essentially a conventional operation comparable in scale with other mining operations, though not as large as many.

Uranium occurs principally in deposits of pitchblends found in Canada, the Belgian Congo and Czechoslovakia and also as carnotite and autunite in the western United States. Other deposits of uranium are found at numerout points throughout

*The terms "nuclear inflammability," "burning" and "fuel" refer to nuclear reactions which resemble ordinary combustion only in the sense that "fuel" material is used up in a self-sustaining process which releases energy. The nuclear reactions are otherwise quite unlike ordinary combustion, and do not for example, require oxygen.

†"A Report on the International Control of Atomic Energy" by the Lilienthal Board; Press Release of the United States Department of State, April 9, 1946; "Scientific Information Transmitted to United Nations Atomic Energy Commission by the United States Member," Vol. 1, p. 18.

the world. The production at the start of the war was reported as not far from a thousand tons of uranium content per year.** Perhaps the principal difficulty which bears directly on the problem of control is that uranium is derived not only from uranium ores. In many cases, uranium is derived, or might be derived, as a by-product from the ores of other metals, mainly vanadium, and also by means of retreatment of the new and old mine wastes, mill tailings, and the wastes and slags of the chemical and metallurgical plants, etc.

Thorium occurs principally in monazite sands in India, Brazil, the Dutch East Indies, Australia, and elsewhere.

It is to be expected that the search for new deposits of uranium and thorium, and the introduction of extraction methods for low grade deposits will greatly increase the potential supplies.

PROCESSES FOR THE SEPARATION OF U-235

There are two principal processes by which concentrated nuclear fuel can be produced from uranium: By the separation of the isotope U-235, and by the burning of the U-235 content of natural uranium to produce plutonium.

In the separation process, the first stage is chemical purification and the preparation of special uranium compounds, among them gaseous uranium hexafluoride.

Separation may be effected in several ways: In the gaseous diffusion method, the uranium compound in a gaseous state is forced through porous barriers. The U-235 isotope, being very slightly lighter, can get through the barrier somewhat more rapidly than U-238. By a large number of repetitions of the process it is possible to secure material which is considerably enriched in U-235. This is the process reportedly used in the very large plant at Oak Ridge, Tennessee. A related process depends on the difference in rate at which the two isotopes can move through a liquid layer between a heated wall and an adjacent cool one. This process is called thermal diffusion, and is also reported to have been used on a moderate scale at Oak Ridge. The third process, reportedly used on a large scale, is electro-magnetic separation. Intense beams consisting of molecules of a gaseous compound are projected into a magnetic field which bends their paths. The molecules containing the lighter uranium atoms, that is U-235, turn more sharply than the heavier molecules containing U-238, with the result that the isotopes are separated. There is an important difference which distinguishes this process from the others: the electromagnetic method can yield substantially complete separation of the isotopes as compared with a very gradual enrichment by the other processes, but does it only at the price of limited production. These methods require either many stages in the process of gradual enrichment (as in the diffusion methods) or many units operating in parallel to provide significant quantities (as in the electro-magnetic method).

The output of the isotope separation plant consists of uranium compounds enriched in U-235 content to a degree determined by their intended use. That is to say, the nuclear fuel is now less dilute, and after appropriate processing, is ready for use in industrial reactors or for the production of bombs.

PROCESSES FOR THE PRODUCTION OF PLUTONIUM

Another process for the production of a pure nuclear fuel is to make plutonium from uranium. This involves a series of operations for the careful purification of the incoming uranium, the partial conversion of U-238 to plutonium in a primary reactor, the extraction and decontamination of the plutonium, and chemical and metallurgical processing to put it into usable form for reactors or bombs.

**Engineering and Mining Journal, Vol. 146, p. 80, Sept. 1945.

The chemical purification of the uranium compounds as they come from the refinery differs from usual industrial processes because of the extreme purity required. The many impurities which would absorb neutrons and thus quench the chain reaction of the reactor must be removed. The quantity of materials to be handled, and the rigid purification required (several impurities may not exceed one part in a million), combine to make the operation a difficult one. Other materials (known as "moderators") are required in the construction of the reactor, and these have also to be of extreme purity. An alternative to the production of very pure graphite or beryllium for this purpose is the production of heavy water, a difficult and large scale operation in view of the quantities needed.

The primary reactor is a very large structure containing slugs of unenriched uranium metal interspersed through a moderator material such as graphite. In the reactor a chain reaction is set up, which consumes some of the U-235 and produces excess neutrons. Some of these neutrons are absorbed by the U-238 and convert it to plutonium-239.

The uranium slugs, after use in the reactor, contain in addition to the unchanged uranium, plutonium and a variety of radioactive elements formed as by-products of the chain reaction. The separation of plutonium, while reasonably straightforward chemically, is a highly specialized operation because the low initial concentration of plutonium poses special problems, because the entire process must be handled by remote control to avoid danger from radiation, and because it is difficult to dispose of the radioactive by-products present with the plutonium and the uranium.

The plutonium compounds from the extraction plant are converted into metallic plutonium in a chemical and metallurgical plant. The plutonium metal from this plant is ready for use either in an industrial reactor or for the production of bombs.

SCALE OF THE INSTALLATIONS FOR PRODUCING NUCLEAR FUELS

Some of the complexities in the production of Pu-239 and uranium enriched in U-235 have been indicated in the discussion of the processes. An indication of the huge scale of the operations required for bomb production has been given in published descriptions of the plants which were constructed by the United States during the war. Some data on cost and physical dimensions taken from the United States publications has been tabulated in Appendix 3. One striking aspect is the small fraction of the total cost required for the facilities for bomb fabrication, as distinct from the production of the nuclear fuels for use in the bomb.

THE PRODUCTION OF URANIUM-233

Refined thorium compounds, after careful purification, yield thorium which can be incorporated into a primary reactor for the production of U-233. Chemical separation and the final production of U-233 in pure form require processes analogous to those for plutonium.

Naturally-occurring thorium is a single isotope and therefore no process of separation analogous to the separation of U-235 from uranium is involved. Since this isotope has not the property of "nuclear inflammability," a primary reactor using thorium alone would have no fuel to maintain the chain reaction. It can only be used therefore if a fuel material is added. In general, the available information indicates that processes involving thorium have been less thoroughly explored than those utilizing uranium. Nevertheless, in this report U-233 is included as one of the nuclear fuels, even though the avail-

able information states only that it is theoretically possible to utilize U-233 in reactors and in bombs.

SUMMARY

Atomic energy in amounts of importance for industrial activities is obtainable only from nuclear chain reactions which, like fire, are self-propagating.

Three materials are known which are useful as nuclear fuels for a self-sustaining chain reaction: only one of these (U-235) occurs in nature, constituting 0.7 per cent of ordinary uranium; the other two (Pu-239 and U-233) can be produced by nuclear reactions from uranium and thorium, respectively.

Nuclear fuels may be burned at a controlled rate in a reactor, or in a runaway explosion as in a bomb.

The raw materials for atomic energy, uranium and thorium, occur in widely scattered ore deposits. Mining and processing of the ores are more or less conventional operations. Pre-war production was of the order of one thousand tons of uranium content per year.

The partial separation of U-235 from uranium to provide a high grade nuclear fuel has reportedly been accomplished by gaseous diffusion, thermal diffusion, and electro magnetic methods. All of the processes require many separate stages or units, and huge installations, for significant production of concentrated fuel.

Plutonium (Pu-239) is formed by a nuclear reaction from uranium, specifically, from the abundant isotope, U-238. Highly purified uranium and very pure graphite can be fabricated into a primary reactor which will maintain a chain reaction burning the U-235 fraction of the uranium, and, at the same time, utilize this reaction to produce Pu-239 from the U-238 fraction.

The production of significant quantities of Pu-239 requires very large installations comprising highly specialized chemical extraction plants in addition to the primary reactors.

Cost data for the United States atomic bomb installations indicate a comparatively minor outlay for bomb fabrication as compared with the cost of production facilities for U-235 and Pu-239.

Thorium, as a source of nuclear fuel (U-233), differs from uranium in containing no "inflammable" fraction corresponding to the U-235 in uranium. Thorium can, therefore, be used in a reactor as a source of U-233 only if nuclear fuels are also added.

CHAPTER II

UTILIZATION OF NUCLEAR FUELS

The practical applications of atomic energy all depend upon the energy, radiations, and radioactive materials resulting from nuclear chain reactions. Three fuel materials can be obtained in practical quantities: U-235, Pu-239 and U-233. The character and scale of the equipment in which these fuels are utilized differs for different applications and can best be considered in terms of the intended uses.

POWER

The characteristic of a nuclear chain reaction which is perhaps most striking is the enormous quantity of energy released in the burning of comparatively small quantities of nuclear fuels. The consumption of a kilogram (about 2.2 pounds) per day of uranium-235 generates heat at the rate of approximately a million kilowatts. The same amount of heat could be obtained by burning about 3000 tons of coal per day, enough to supply the power and light for a city of about a million.* The use of atomic energy for the large scale generation of electric power and for industrial heating are therefore challenging possibilities. Initially, at least, nuclear reactions will probably be used to generate heat which, by means of a heat exchanger, can provide steam for conventional turbo-generators producing electrical power. Many technical problems are involved in the use of atomic energy for power, but the development seems straightforward.

The large primary reactors which have been constructed for plutonium production generate a great deal of heat in the process, and might, by redesign, be used for power production. It seems probable that the size of reactors could be reduced by using concentrated fuel, although there are engineering limitations set by the rate at which heat can be removed from the structure, and the requirements for shielding personnel from the intense radiations. Published reports indicate that concrete walls more than five feet thick completely surround the large reactors at Hanford. Published estimates indicate that units for ships may be developed, but that smaller mobile units are unlikely on account of the bulk of the shielding required for the protection of personnel from the harmful effects of the radiation.

It appears likely that reactors producing large quantities of power could be built which would not contain U-238 or thorium from which new nuclear fuel would be produced. Such reactors would be consumers only of nuclear fuel which would have to be produced elsewhere.

Reactors using so-called "denatured" fuel material will be considered in Chapter III.

A possible complication in the operation of atomic power plants lies in the cumulative effects of the materials left over from the chain reaction. These comprise a variety of elements, usually called fission products, some of which may absorb neutrons to such an extent that they would reduce the efficiency of the reactor, or even stop its operation. Decontamination plants, analogous to the plants for extracting the plutonium produced in primary reactors, may therefore be needed.

Information is lacking on another important aspect of the operation of atomic power plants: This is the question of whether or not enough additional fuel can be made in a power reactor to replace the original supply of nuclear fuel being consumed. If not, the world supply of nuclear fuels is measured by the amount of U-235 present in nature, extended a few-fold by such additional quantities of Pu-239 or U-235 as are generated in the consumption of U-235. On the other hand, if the regeneration of nuclear fuels can fully replace the original materials, then all of the U-238, one hundred and forty times as plentiful as U-235, and also the world's supply of thorium which is more plentiful than uranium, constitute potential nuclear fuels.

Published information indicates that the generation of electric power from atomic energy is still in the early developmental stage, with active work in progress at Oak Ridge, Tennessee. Costs may be competitive with electric power from coal, at least in some parts of the world.

RADIATIONS

In addition to the energy generated as heat in the operation of a reactor very intense radiations, particularly gamma rays and neutrons, are released. Such radiations from radium, large X-ray units, and cyclotrons, have been used in the past for radiation therapy. The intense radiations available from reactors should make them useful for these purposes. In industrial chemistry, new processes appear possible based on the chemical actions induced by intense and penetrating radiation. In physical research, the intense beams of radiations from reactors are already proving powerful tools.

*At ten percent efficiency, the heat obtained by burning a kilogram of U-235 per day could be converted into about 100,000 kilowatts of electric power.

RADIOACTIVE ISOTOPES

In addition to radiations, the operation of a reactor produces comparatively enormous quantities of radioactive materials, approximately a kilogram of fission products for each kilogram of nuclear fuel consumed. This material is equivalent in its effects to many thousand times the same amount of radium because of the more rapid rate at which many of its constituents disintegrate. Although the fission products consist of some thirty chemical elements of medium atomic weight, radioactive isotopes of most other elements can be produced as a result of neutron absorption. Since a great many neutrons exist inside and around an operating roactor, it is easy to use them in the preparation of substantial quantities of the desired isotopes. The availability of radioactive materials in adequate quantities should permit a renewed and very vigorous attack by tracer techniques on many research problems, notably in physiology, medicine, and the mechanism of chemical reactions. Some of the fission products may possibly replace radium in cancer treatment in the future. There is in addition the possibility of new techniques based on the selective localization in malignant tissues of chemical compounds containing radioactive elements.

Comparatively small reactors will usually be adequate, and in many cases most convenient, for applications requiring radiations and radioactive isotopes, although the latter may often be obtained as by-products from large reactors operated for other purposes.

ATOMIC BOMB

The atomic bomb constitutes a highly specialized type of reactor in which the principal design requirement is that as much as possible of the nuclear fuel in the bomb shall be consumed in the very short time before the bomb bursts apart. Clearly, highly concentrated fuels are required to permit the most rapid combustion. Such materials will explode spontaneously as soon as the quantity of material in a single piece becomes large enough that the neutrons are effectively confined and utilized. The detonation of the bomb is then a matter of bringing together rapidly two or more pieces of fuel material which together exceed this critical size. Little more information than this has been released about the construction of atomic bombs, except that the critical size was predicted in 1941, within very wide limits, as more than two and less than one hundred kilograms.* In all probability, highly skilled personnel and specialized facilities are required for bomb production, but a large establishment does not appear to be necessary.

ESTIMATES OF THE AMOUNT OF POWER OR THE NUMBER OF BOMBS AVAILABLE

An estimate of the total electric power, or alternatively, of the number of bombs, which might result from the utilization of the world's production of uranium can hardly be made with any reasonable accuracy. The present production of uranium, the amount of material required for a single bomb, and the fraction of U-238 (or thorium) which can be utilized for power are all figures which are not available. However, the annual production of uranium in 1939 can be estimated at approximately one thousand tons (uranium content in ores) on the basis of data in "Engineering and Mining Journal" for September 1945.

One might, as an example, assume that one thousand tons of uranium per year are available for the production of electric power. One thousand tons of natural uranium contain about seven thousand kilograms of U-235. This amount of U-235, used in power plants having an overall efficiency of ten percent, could provide two million kilowatts of electric power for one year. If all of the uranium (and thorium) can be used, the amount of power available would be several hundred million kilowatts. In this connection, it may be of interest to quote a passage from the report of the Lilienthal Board: "We have examined in some detail . . . the technical problems of making available heat and power on the scale of present world consumption from controlled nuclear reactors. We see no significant limitations on this development, either in the availability or in the cost of the fundamental active materials."

As an alternative example, if one were to assume that one thousand tons of natural uranium, containing approximately seven thousand kilograms of U-235, were available each year for the making of bombs, then using the limits on critical size given above as the amount of U-235 required for a bomb, the number of bombs which could be produced from all of the available uranium would be between seventy and thirty-five hundred per year.

Summary

There are three nuclear fuels (U-235, Pu-239 and U-233) which can be used in a sustained chain reaction yielding enormous quantities of heat, radiations, and radioactive materials. The consumption of one kilogram per day of U-235 releases energy at the rate of approximately a million kilowatts, and produces nearly a kilogram of radioactive materials per day.

The large scale production of electric power from atomic energy appears feasible, though still in the development stage.

The engineering design of a large scale power plant will determine whether it requires concentrated nuclear fuels such as are used for bombs or can use dilute or denatured fuel unsuitable for bomb manufacture; also, whether or not further production of nuclear fuel (Pu-239 or U-233) accompanies power production.

Small installations for power production appear unlikely for several reasons, one of which is the thick shields required to provide protection from radiation.

The intense radiations and the substantial quantities of radioactive material available from a reactor may be expected to find important applications in medicine, industrial chemistry, and nuclear research. The availability of radioactive isotopes opens the way for the intensive use of tracer techniques in chemical, physiological and medical research.

Comparatively small reactors will be adequate for most of these applications of radiations and radioactive isotopes.

The production of atomic bombs requires comparatively large quantities of concentrated nuclear fuels, and correspondingly large installations for the separation of U-235 or the production of Pu-239 or U-233. Bomb manufacture is a highly specialized, but hardly a large scale, operation.

Examples based on published information suggest that raw materials are readily available for the production of from 70 to 3500 bombs per year, or for the generation of electric power at a rate of two million kilowatts, and possibly many times this rate.

CHAPTER III

PEACEFUL USES OF ATOMIC ENERGY AND THEIR BEARING ON CONTROL

INTRODUCTION

In the foregoing chapters we have given a general description, based on published information which is limited but which we believe is reliable, of the various activities involved in the production and use of nuclear fuels. It is to be expected that, in a peaceful state of the world, such activities will be carried on for beneficial purposes. Most of these same activities are also involved in the production of atomic weapons. Each of them involves an element of danger, since attempts may be

*Report of the National Academy of Sciences, quoted in Section 4.49 of "Atomic Energy for Military Purposes" by H. D. Smyth.

**"A Report on the International Control of Atomic Energy," Section II, Chap. 3. 10th Paragraph.

made to divert materials or to seize materials or installations with the aim of using them for the production of atomic weapons. In the following discussion, the words "danger" and "dangerous" will always be used with this connotation. In this chapter we propose to analyze the relative importance of these dangers and to explore to some extent the problem of possible safeguards against them.

As regards diversion it may be observed generally that the later the stage at which diversion occurs, the more immediate is the danger arising from it because fewer subsequent operations, less time and fewer plants are then necessary to produce weapons. It should also be observed that attempts to divert materials at certain stages might be so planned as to take advantage of the fact that losses in processing are normal in metallurgical and chemical operations. The ease of diversion and the nature of necessary safeguards varies from stage to stage, and each will be considered in turn. It must be stressed, however, that all of the operations are inter-related, and the effectiveness of safeguards at any one stage depends in large measure on the safeguards erected at other stages.

In addition to diversion there is the possibility of seizure either of the fuel materials themselves or of the facilities for producing them. This will be dealt with in the final section of the chapter.

Uranium and thorium are, as far as can be forseen, the only naturally occurring substances from which nuclear fuel in significant quantities can be produced. Hence, these substances play a fundamental and unique role in the control of atomic energy.

MINING OPERATIONS

Uranium and thorium are obtained from ores and deposits. It is clear that, unless appropriate safeguards are taken ensuring that material cannot be diverted from the mining operations, attempts may be made to use it for weapons. The consequences of diversion at this stage will not immediately be serious since it would require considerable time and industrial activity—how much precisely would depend on the facilities available—before weapons could be produced by clandestine operations.

In considering safeguards over mining operations, the following circumstances will be helpful. The mining operations, although widely different for the rich deposits and for the low grade deposits, would always be on a significant scale; they take place along conventional lines and involve the handling of large quantities of ore, concentrates and tailings. It would hence appear feasible to keep track of the distribution of any significant quantities of material from the mines. A special significance must be attached to the devising of adequate safeguards against the diversion of raw materials, since none of the subsequent operations can proceed without uranium, or uranium and thorium.

EXTRACTION FROM ORE-CONCENTRATES AND PRODUCTION OF URANIUM AND THORIUM COMPOUNDS

Extraction and production of uranium and thorium compounds involve somewhat less bulk of material than has been considered in the previous section and may take place in plants far removed from the mines, as is the case in Canada. The processes involved are carried out in chemical plants of ordinary size and the products are still somewhat bulky. The processes normally involve losses comparable with those in other industrial chemical activities. These provide an opportunity to conceal diversion by making it appear that only process losses have occurred. Therefore, only the application of very close and careful safeguards would provide an adequate assurance against the diversion from those plants of purified chemical compounds of natural uranium or thorium for the surreptitious production of explosive material for atomic weapons.

PRODUCTION OF METAL AND PREPARATION FOR INSERTION IN REACTORS

Preparation of the metal from the uranium or thorium compounds also involves process losses which may be used to conceal diversion of material. The quantities of materials handled are less and the difficulties in detecting diversion are greater than those in the chemical plants discussed in the previous section. There is also the possibility of diversion during the machining and the mechanical preparation of the metal for its insertion in atomic reactors. Just as in the previous case, very careful safeguards will be needed to prevent the danger resulting from such diversion.

PRODUCTION OF NUCLEAR FUELS

Production of nuclear fuels is the crucial stage in the operations. Both separation plants for the production of uranium enriched in U-235 and the reactors and extraction plants for the production of plutonium or U-233 deliver nuclear fuel, which, under proper conditions, may be used directly for the manufacture of atomic weapons. According to the published statements available to us, the installations necessary for weapon manufacture are relatively small and the time required is relatively short if the necessary high-skilled personnel is available and the procedure is known. If therefore the strictest safeguards are not taken to prevent the material in the installations producing nuclear fuel from being diverted, the danger is extremely serious.

The technical nature of the processes involved in the production of nuclear fuels is different for the different types of plants concerned. Very large installations are required, together with highly skilled personnel and methods differing widely from usual industrial methods. The final nuclear fuel product is very small in bulk compared with the quantities of material which are processed. It is possible that even those managing such plants will not find it easy to keep track in a quantitative way of the flow of materials, in much the same way as is the case in usual industrial refinery and extraction plants. These technical facts should be borne in mind when devising the safeguards against diversion mentioned above. It is clear that such safeguards should not only reckon with the materials in the installations themselves, but also with the stocks of purified product.

REMARKS ON OPERATION OF SECONDARY REACTORS

Secondary reactors, i.e., reactors which are fed with nuclear fuel especially prepared from the products of separation plants or of primary reactors, can be designed in various ways, depending on their purpose. Secondary reactors for research and medical purposes would be of low power and could be designed so as to contain insignificant quantities of nuclear fuel. These would be unimportant as possible sources of diversion, unless present in large numbers.

Secondary reactors for the production of electric power or industrial heating would be comparable in fuel consumption to primary reactors, i.e., the reactors which are fed with natural uranium. If they regenerated fuel, they would afford opportunities for diversion similar to those afforded by large primary reactors and in order to avoid this serious danger, the same strict safeguards would be required for both. If the secondary reactors were designed so as not to regenerate fuel, safeguards would still be required in relation to the fuel supply and to the circumstance that, by redesign and rebuilding, the reactor might be converted to other purposes.

It has been suggested* that secondary reactors for electric power or industrial heating, designed so as not to regenerate explosive material, might operate on "denatured" fuel.** If so, and to the extent that this proves to be technically feasible

*See Press Release of U. S. Department of State, April 9, 1946, and "A Report on the International Control of Atomic Energy" by the Lilienthal Board, Section II, Chapter 5, Paragraph 10.
**See Chapter I.

and effective, diverted material would not be usable for weapons without further processing, involving large plants and appreciable time.

SEIZURE OF INSTALLATIONS

We have been discussing the possibilities of clandestine diversion of materials from the peaceful activities in the domain of atomic energy, but we must not overlook that with certain systems of control one would have to consider the possibility that plants or materials might be seized. This implies a danger, the seriousness of which would be greatest in the case of seizure of stocks of concentrated nuclear fuel, because from that stage weapons could be produced most quickly and in relatively small plants. Next in order of seriousness would be the seizure of plants producing nuclear fuels. A wide geographical dispersal of stocks and plants and the restriction of stocks to minimum operating levels would reduce the risk that a large quantity would be involved in a single seizure. Seizure of mines or of facilities at other early stages would only be of advantage to those desiring to make weapons if they had at their disposal a plant capable of producing nuclear fuel.

CHAPTER IV
CLANDESTINE ACTIVITIES

Clandestine manufacture of atomic weapons from nuclear fuels diverted from stocks or from the plants producing such fuels would be extremely difficult to discover because the operations involved can be carried out in comparatively small installations which could easily be concealed. This emphasizes again the importance of preventing the diversion of nuclear fuels which we have stressed in the previous chapter.

If it were sought to divert materials from earlier stages of production, or from undisclosed mines, into the production of atomic weapons, large and complicated installations would have to be clandestinely operated in order to produce the nuclear fuels. The construction of such plants involves a large scale industrial effort and many tributary activities of unusual character. On the other hand, it might be possible to break up such plants into a number of smaller units and thus make detection more difficult.

It would be difficult to carry on clandestine mining or concentrating of uranium or thorium ores if adequate knowledge of their geological occurrence were available. This is due to the large quantities of material which must be processed and the difficulty of concealing mining operations in general.

The maintenance and strengthening of the international community of scientists, the free exchange of scientific information and an increasing awareness among all scientists of one another's research activities would assist in making less likely the application of research talent to clandestine activities.

It is clear that the major assurance against clandestine activities would lie in the existence of effective safeguards applied to known peaceful activities.

CHAPTER V
FUTURE DEVELOPMENTS

Both layman and scientists are apt to believe that in the future scientific discoveries and technical inventions will be made which will bring further development of the activities in the domain of atomic energy. This raises a new question regarding control. For example, the possibility has been considered, in our discussions, that some day a method might be devised by which the separation of U-235 from natural uranium could be realized by methods less elaborate and costly than those actually used in the United States. It is clear that production of atomic weapons would thereby become easier.

There is also the possibility that some day raw materials other than uranium and thorium might be found suitable for the production of nuclear fuel. At the moment, such a possibility is highly speculative. Whatever the future may bring, those charged with responsibility for maintaining safeguards on atomic energy will best be able to make necessary adaptations in these safeguards if they are intimately associated with and participating in new developments in the entire field.

CHAPTER VI
SUMMARY AND CONCLUSIONS

The substances uranium and thorium play a unique role in the domain of atomic energy, since as far as we know these are the only raw materials from which the nuclear fuel required for the development of atomic energy can be obtained. There is an intimate relation between the activities required for peaceful purposes and those leading to the production of atomic weapons; most of the stages which are needed for the former are also needed for the latter. The character of the different stages of the activities has been discussed in order to explore at each stage the elements of danger and to some extent the problem of safeguards against these dangers.

With respect to mining operations, which are of special significance as the first step in these activities, it appears hopeful that safeguards are not too difficult. Particular attention should be paid to the installations in which concentrated nuclear fuel is produced since the product lends itself immediately to the production of bombs. Unless appropriate safeguards are taken at each of these stages, it will be difficult to insure that no diversion of material or installations will take place.

With regard to the question posed by Committee 2, "whether effective control of atomic energy is possible," we do not find any basis in the available scientific facts for supposing that effective control is not technologically feasible. Whether or not it is politically feasible, is not discussed or implied in this report, nor is there any recommendation of the particular system or systems by which effective control can be achieved.

Appendix 3—Some Relevant Data on Cost and Size of U. S. Atomic Bomb Project

A. General (including construction and other activities)
Funds appropriated to June 30, 1945.....$1,950,000,000*
Construction workers at peak.....125,000**
Operating personnel on August 6, 1945.....65,000**

B. Major Construction Costs and Indications of Size of Installations***

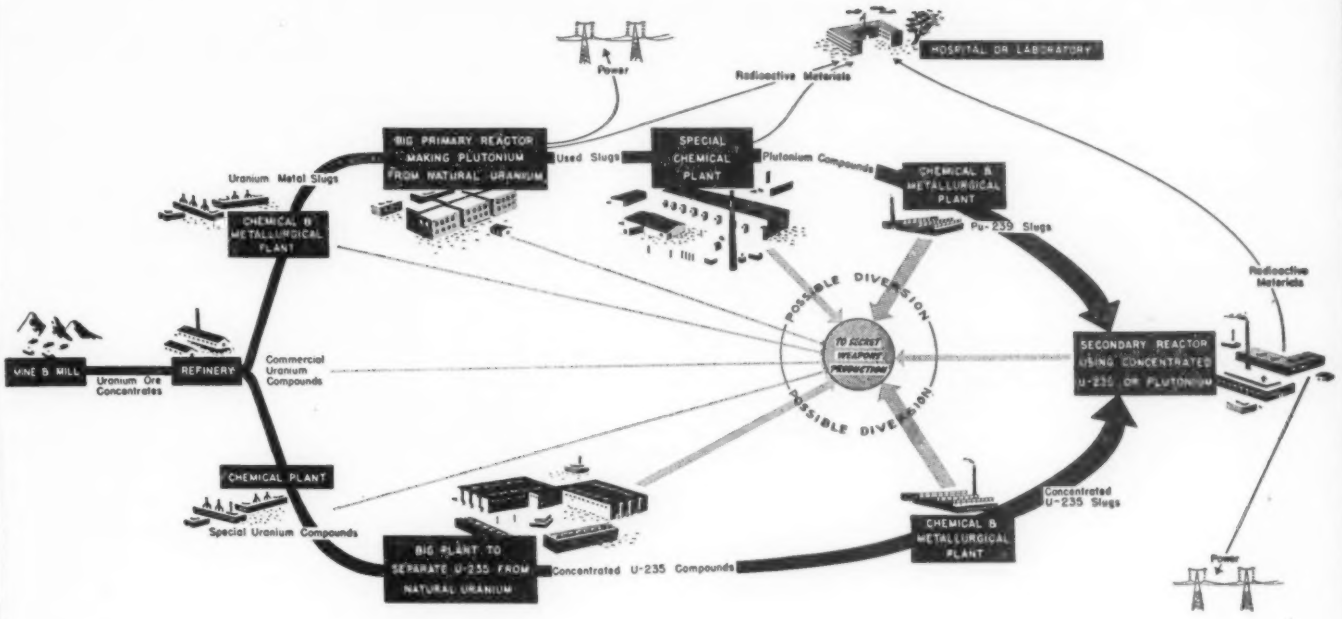
Installation	Expenditures in Millions of Dollars	Construction Workers at Peak	Size of Installations.
Gaseous Diffusion	545	25,000	Four story building, ½ mile long, ¼ mile across, covering 60 acres.
Electro-Magnetic	350	13,200	175 separate buildings including 9 major processing structures.
Thermal Diffusion	10.5	.....	Main building, 525 x 82 ft., 75 ft. high.
Experimental Reactor at Clinton	12	3,247	Designed for 1,000 kilowatt capacity.
Hanford	350	45,000	600 square-mile site. 3 huge reactors and chemical separation plants. 780,000 cu. yds. of concrete.
Los Alamos	60	.....	.....

*Press Release by Secretary of War Stimson, August 6, 1945.
**Press Release by President Truman, August 6, 1945.
***Taken from the following publications:

"Hearings before the Special Committee on Atomic Energy," United States Senate, November 29, 1945. Government Printing Office.

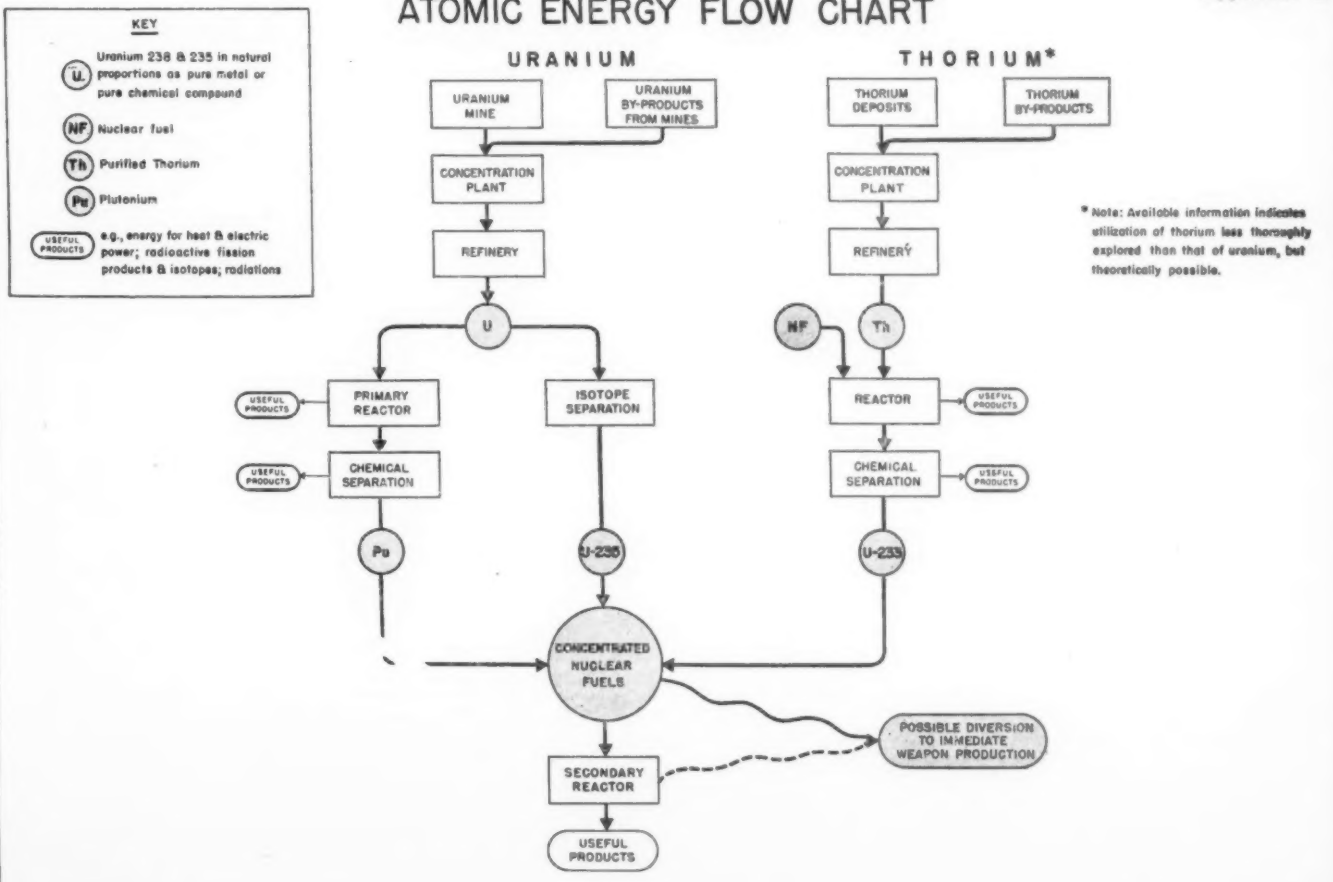
Articles in **Engineering News-Record**, December 13, 1945.

PICTORIAL CHART OF THE PROCESSES USING URANIUM TO PRODUCE ATOMIC ENERGY



Note: Waste products from the various stages in the processes may be reprocessed to recover the uranium or plutonium which they contain. For simplicity, such operations have not been shown.

ATOMIC ENERGY FLOW CHART



How Can Atomic Energy Be Controlled?

. . . . . David E. Lilienthal

Can atomic energy be so developed and so controlled that it will be used only for the advancement of human welfare and not be used for war and destruction? As we meet here tonight this is probably the world's number one question. Since June 14th a group of men meeting in New York City have been patiently seeking for an answer to this tough problem. This is the Atomic Energy Commission of the United Nations, made up of representatives of twelve countries, with Mr. Bernard Baruch the American delegate.

No answer to this question will be genuinely workable unless it is agreeable to every one of the Great Powers and all, or substantially all, the nations of the world. This is quite an order. In fact, *quite* an order. It may be something like insisting that a fellow who never in his life has broad-jumped more than ten feet must jump twenty feet. But if he feels he just *has* to jump twenty feet, if a deep chasm lies before him, and something pretty hungry is chasing him, then twenty feet is still one hell of a jump—but because he has no easy alternative, it's not impossible. Well, the world has no easy alternatives about atomic energy; none that I can see. If an answer can't be found, one that this country and Russia and the other nations find acceptable and workable, then we're bound to have a feverish arms race. This will not be just an atomic arms race (though atomic weapons will probably lead the list) but one clear across the board. If that happens, scientist and technical men will simply have to do what all the rest of us must then do, that is, change our whole way of living. And there wouldn't be much peace of mind while we're making the change. Instead of devoting your skills as chemists to improving the lot of men, as you would prefer to do, you, like all the rest of us—if we get into this kind of arms race—will be working like mad to find ways of scattering our cities so as to defend ourselves, and spending our energies devising ways of destroying our potential enemies. Not a pretty prospect for science or industry, or civil liberties, or nerves, or anything else.

It was scientists and technical men—prominently among them chemists—who gave the world the large-scale release of atomic energy. This is the supreme achievement to date of the scientific spirit and the scientific method. It is my own opinion that the only hope to control atomic energy and prevent its use for destruction lies in applying the scientific spirit and the scientific method to this problem. In a world thus far largely run by the ideas of politics and legalism, I freely admit that this would be something quite novel. But considering how unattractive are the alternatives, I don't believe that the twenty foot broad jump is out of the question, and I doubt if you do either.

The averting of war and the maintenance of peace are traditionally described as political problems, or as it is sometimes put, "These are matters calling for political decisions, reached and carried out by political methods." Typical political methods is domestic affairs as well as international relations are quite familiar to all of us. Their practitioners sometimes include business, labor and farm leaders, as well as politicians and statesmen—even, once in a while a scientist. And when a scientist goes in for political dogmatism, he can make a politician look scientific by comparison!

The political method, generally speaking, is based on the process of *first* deciding what the answer you and your side wants, and *then* scurrying around for evidence and arguments and public opinion and force to support the answer you started with in the first place. Political methods—I am over-simplifying a bit, but not much—are based on three procedures so far as the people are concerned as follows:

First: Tell the people what you know *they want to hear*—regardless of the facts. This gives great scope for orators, slogan-makers, and dogmatists.

Second: Tell the people what *you* want them to hear—regardless of the facts. This is the technique of the well-poisoner.

Third: Tell 'em nothing, and make 'em like it. This is an ancient art, but its modern practitioners have brought it to a new high level. .

Political methods are generally quite in contrast to the scientific spirit and method. In his Novum Organum, Francis Bacon said many many years ago: "We cannot command Nature except by obeying her." The scientist, essentially a humble man, obeys Nature by honestly observing and then truthfully recording *not* what he *wants* to find, but what in truth he *does* find. The essence of the scientific method and spirit to me—a layman—is that it does not start with the answer, but with the facts, and draws its insight and its overtones from the facts.

It's not often that there is an opportunity to analyze what is called a political problem in a scientific spirit. But something of the sort did happen last winter. The product was an idea embodied in a document published by our State Department called "A Report on the International Control of Atomic Energy." The proposals of that Report for the creation of a world-wide Atomic Development Authority have since been accepted by our President, Secretary Byrnes, and Mr. Baruch and his associates as basic to the American proposals presented by Mr. Baruch in an historic address to the UN Atomic Commission and to the world.

This Report represented the work and the unanimous agreement of a Board of Consultants of five men. We were men of widely differing backgrounds and experience. But all five of us had this in common—we had all had responsibility for technical enterprises, and therefore had grown accustomed to the methods of tackling problems that are characteristic not of politics but of technology. Chester Barnard, one of our associates, President of the New Jersey Bell Telephone Company, thinks scientifically about organization. Dr. Robert Oppenheimer, a physicist, was wartime director of the atom bomb plant at Los Alamos. Dr. Charles Thomas, a chemist and one of this Society's distinguished members, is director of Monsanto's research activities, and in charge of research at the atomic energy plant at Oak Ridge. Harry Winne is vice-president of General Electric in charge of engineering policy. Your speaker is Chairman of TVA. So that all of us had rather extensive and responsible experinece in undertakings based on scientific and technical knowledge. This was indeed a strange team to be asked to try to find an answer to what is classified as a "political" problem.

We five locked ourselves up for two months, had the whole array of facts before us, and came up with a plan all of us believed was workable. That plan has been widely discussed and is fairly well known. We urged that the people of the world agree to entrust to a world agency, the Atomic Development Authority, the control and management of all activities concerning atomic energy that are dangerous—that is, dangerous to the security of the world—activities that are steps on the road toward the making of atomic bombs. These dangerous steps begin with the raw material: uranium and thorium, Under our proposed plan, factories to produce fissionable materials would all be owned and operated, not by rival nations, but by this world cooperation functioning under world law and responsible to all the people.

But it is *how* our Board of Consultants went about trying to find a plan that is in some ways as important as the answer

we came up with. For we didn't follow the typical political method of starting with the answer all neatly laid out, and then look around for facts and arguments to support our pet notion. We didn't start, for example, by asserting that the answer was world government and then pick out facts that would fit that answer. Nor did we say, "National sovereignty must in no wise be infringed," and then try to squeeze out a plan that would fit that dogma. No, we started somewhat as a chemist might, tackling a technical problem: with the facts as he found them.

You recall that a year ago when the world saw for the first time the fantastic destructiveness of the atomic bomb, many Americans said, "Now, this won't do; this must be the last time that an atomic bomb is used. The people of the world must agree to outlaw the bomb." What was meant was that the nations would all sign a treaty that solemnly promised that none of them would ever in secret or otherwise make these bombs and use them in a war. All the nations would devote themselves exclusively to the many wonderful peaceful uses of atomic energy—for electric power, for a war on cancer and other diseases, and research in a hundred fields.

My four associates and I placed the facts alongside this idea of eliminating the bomb by international agreement, and as a consequence we were forced to discard the idea. For these facts made it clear that there was no security whatever for people anywhere, no prospect of a moment's freedom from fear of an atomic armament race if this is all we had to offer—this outlawing by international covenant.

What facts? Well, fact No. 1 is this: the same materials and operations required to put atomic energy to peaceful purposes are adaptable, virtually without change, to the making of the stuff that goes into atomic bombs. This is true through almost the whole course of producing atomic energy.

In the light of the facts it was just political hoorah to talk about nations concentrating on peaceful purposes as if that called for entirely different processes and materials from those used for destruction. Once you have produced some of this dangerous material there are ways of doctoring or denaturing it, to make it rather safe, and not effective for bombs in that form; but you must *begin* with substances that however useful for producing electric power or for research, can just as readily be used to destroy the cities of mankind. There's a fact—and a fact is a stubborn thing and no amount of political dogma can do anything to change a fact. (And there is another thing about a scientific fact: it pays no attention to national boundaries. There are no such things as American neutrons, say, and som edifferent kind of Russian neutrons, and British neutrons. A neutron doesn't know about boundary lines.)

These being the facts, what does an international covenant never to use atomic bombs amount to? The nations would all go through the process of signing their names to a treaty, agreeing never to make atomic bombs, agreeing that they will forbid their citizens to use fissionable materials except for peaceful purposes. But under the treaty each nation will be permitted to go on mining uranium and thorium and putting them through a plant that will produce materials that however valuable for peace are also readily suitable for a bomb.

Well, how much security—how much peace of mind would anyone get out of that? Mighty little. For as is well known the atomic bomb is a surprise weapon and a relatively cheap one. We are reliably advised that several hundred of these bombs used on a nation's cities would finish off any industrial nation of the world. The bomb was originally developed in secret and, assuming closed borders, could probably be developed by a nation in secret again. We concluded, unanimously, that if nations were rivals in the development of atomic energy materials that could be diverted rather simply from open, peaceful uses to secret, warlike purposes, an agreement by each nation to outlaw the bomb might even be worse than nothing at all. For it would create suspicion and fear as to what the other fellow is doing behind closed factory doors and in hidden and secret laboratories and bomb plants; and fear and suspicion breed wars.

Then we said to ourselves: Suppose the world agreed to join together to crack down on anyone who violated the international agreement; who despite the agreement went ahead and made and used atomic bombs. We rejected that plan, too, for we could find precious little security in a plan to punish a nation *after* it had dropped hundreds of bombs and killed millions of human beings. As for such punishment as a deterrent, the fact is that there is a premium in atomic warfare in pulling the trigger first, so that your enemy won't be able to retaliate effectively. And there is therefore a great premium on making preparations secretly while your law-abiding and trusting neighbors are depending on international agreements that say on paper that the bomb will not be used. And with that kind of creepy atmosphere to live in, in time everyone would suspect everyone else, no one would have any sense of security, and everybody would be making atomic bombs in secret. The world would not be a very happy place.

But then this was suggested: Why couldn't we have an international inspection agency, to snoop into every factory and plant to see whether nations are fulfilling their agreement not to put fissionable material into bombs? Again we looked at the facts, explored them painstakingly, and the facts forced us to conclude that a plan of inspection as a sole safeguard was quite unworkable. One of those facts was simply this: If an international inspector is to provide security against secret evasions, that inspector must know at least as much about atomic energy as the people he's supposed to watch. And there's the rub. An inspector—a high grade policeman—simply wouldn't know enough to detect a skillful evasion. This is a new field, new developments as you well know are coming along, stepping on each other's heels. Because of new knowledge the plants that are built next year will almost certainly not be like the ones we have in the Tennessee Valley at Oak Ridge or at Hanford in Washington state; and if a nation wanted to mislead the world, it could design them quite differently, so they might look rather innocent to an inspector. In a race between a nation that has scientists trying to design new kinds of plants so the international inspector wouldn't recognize them, and an army of inspectors looking for the only kind of plants they know about, which are yesterday's plants, in that kind of race the inspectors probably wouldn't have much chance. The only people who would be genuinely qualified to protect the world against secret shenanigans would be those who know how to design and operate atomic energy plants—the chemists, the physicists, and the engineers. And that is one weighty reason we urged that world security be protected by a development and operating agency manned by just such technical people, acting not for rival nations, racing each other, but for all nations and all peoples.

Well, this is the way we took one set of facts after another and explored this problem, and the things we rejected as not workable furnished a clue as to what we thought would be workable. It was these objectives, and this same method of analyzing the facts that led the President, and Mr. Baruch and his associates, to present the American proposal for such an Atomic Development Authority. There is a point in remembering that it was Woodrow Wilson who dubbed Mr. Baruch with the nickname "Dr. Facts."

The proposed Atomic Development Authority would not be a mere international detective force, but, as its proposed name implies, a development agency engaged in operations and extensive research. To provide security the ADA must *know*. Professor H. D. Smyth has said that the men on the Atomic Development Authority might well become the elite of the scientific world. "Able men," he continued, "devoted to the

(Continued on page 18)

Official Report on Biological Warfare

. . . . . George W. Merck

The military strength of a nation in war depends not only on the weapons which it actually brings to bear on the enemy but also on the thoroughness with which the nation prepares for all eventualities. This basic military doctrine was followed by the United States in waging war against the Axis.

A type of warfare that might have been employed in World War II—a potential avenue of attack by our enemies—was biological warfare. Biological warfare may be defined as the use of bateria, fungi, viruses, rickettsias, and toxic agents from living organisms (as distinguised from synthetic chemicals used as gases or poisons) to produce death or disease in men, animals, or plants. This type of warfare was not unknown in World War I although it was employed only on a very limited scale. There is incontrovertible evidence, for example, that in 1915 German agents inoculated horses and cattle leaving United States ports for shipment to the Allies with disease-producing bacteria.

In the years between World War I and World War II a general interest in the possibilities of biological warfare was maintained by scientists and military men in many countries, and many came to believe that this type of warfare was possible or even probable in the future. As the interwar period drew to a close, opinion in the United States as to the possibilities of biological warfare was by no means united, but common prudence dictated to those responsible for the nation's defense that they give serious consideration to the possible dangers in this field. The counsel of those alert to the possible danger was formally brought to the attention of the War Department in the fall of 1941, whereupon Secretary Stimson promptly requested the National Academy of Sciences to appoint a committee to make a complete survey of the current situation and of future possibilities.

After careful study, this Committee—known as the WBC Committee—drew the conclusion in its report of February 1942 that biological warfare was distinctly feasible and urged that appropriate steps be taken for defense against its uses. The report stated in part:

> "The value of biological warfare will be a debatable question until it has been clearly proven or disproven by experience. The wide assumption is that any method which appears to offer advantages to a nation at war will be vigorously employed by that nation. There is but one logical course to pursue, namely, to study the possibilities of such warfare from every angle, make every preparation for reducing its effectiveness, and thereby reduce the likelihood if its use."

I

With these conclusions before him, Secretary Stimson recommended to President Roosevelt the establishment of a civilian agency to take full charge of all aspects of biological warfare. Upon the approval of the President, the War Research Service, with Mr. George W. Merck as Director was organized in the summer of 1942 and was attached to the Federal Security Agency. In the interests of efficiency, economy, and secrecy, War Research Service remained a small organization. It served primarily as a coordinating agency and drew on the facilities, personnel, and experience already existing in the Government and private institutions. Its recommendations were implemented by orders and directives issued by the various branches of the Armed Services, particularly the Medical Services of the Army and Navy and the Chemical Warfare Service of the Army. Appropriate Liaison was maintained with the Armed Services, particularly the U.S. Public Health Service, the Department of Argiculture, and the Department of the Interior. Intelligence was obtained from the Army, the Office of Naval Intelligence, the Office of Strategic Services, and Federal Bureau of Investigation; and public relations matters were handled in cooperation with the Bureau of Public Relations of the War Department, the Office of War Information, and the Office of Censorship. A committee of prominent scientists—known as the ABC committee was set up by the National Academy of Sciences and the National Research Council to advise War Research Service on its special research problems.

The exchange of information on this subject which had been inaugurated some months before with the United Kingdom and Canada was continued and provision was made for the interchange of biological warfare personnel between the three countries.

The first major task undertaken by War Research Service was the development of defensive measures against possible biological warfare attack. Measures were taken in cooperation with the Armed Services to protect the supply of water, food, and milk on the mainland; in Hawaii, the Caribbean area, particularly the Canal Zone; and finally all overseas theaters.

An extensive program for the collection of intelligence on biological warfare was established, making use of the intelligence collection agencies of the Armed Forces, the OSS, and the FBI, and arrangements were made to send specifically trained intelligence officers into operational areas to stimulate the collection of intelligence on biological warfare.

The major achievement of War Research Service, however, was the organization of a program of research and development to extend the boundaries of knowledge concerning the use of pathogenic agents as a weapon of war and the means of protection against possible enemy use of these agents. All known pathogenic agents were subjected to thorough study and screening by scientists of the highest competence in their respective fields to determine the possibilities of such agents being used by the enemy. Those disease-producing agents which seemed to offer some promise were assigned to various university and private research laboratories for intensive experimentation in terms of their lethal properties, means of production, and methods of protection against their use. As the program progressed, however, it soon became clear that exhaustive investigations of biological warfare agents, their use as weapons, and means of protection against them could not be achieved without larger scale developmental operations.

In November 1942 War Research Service requested the Chemical Warfare Service of the Army to prepare to assume responsibility for a larger scale research and developmental program involving the construction and operation of specially designed laboratories and pilot plants. The site chosen for these facilities was at Camp Detrick, Frederick, Maryland, where construction was begun in April 1943. When these facilities were put into operation, research projects which had been developed under sponsorship of War Research Service were turned over to the Chemical Warfare Service for further development at Camp Detrick. War Research Service continued to exercise general supervision over the entire field and continued to sponsor fundamental research studies in universities and private institutions and to help secure scientific personnel and equipment for the Camp Detrick operations.

In December 1943, the Office of Strategic Services reported to the Joint Chiefs of Staff that there were some indications that the Germans might be planning to use biological warfare agents. While the evidence that the Germans might use such

agents was inconclusive, there was considerable concrete information available from work which had been carried on in the United States, the United Kingdom, and Canada that attack by biological warfare agents was feasible. Accordingly, it was decided in January 1944 to step up work in this field, particularly in terms of the protection of troops against possible enemy use of these weapons, and to transfer a large part of the responsibility for the biological warfare program to the War Department. The complete transfer was accomplished by direction of the President in June 1944 when the Chemical Warfare Service was made responsible for the program in the War Department with the cooperation of the Office of the Surgeon General on certain important defensive phases. The Navy Department continued to make important contributions to the program and continued to work in close collaboration with the War Department in this field. The research and developmental program was greatly accelerated, although it was directed that no biological warfare agents should be produced in quantity without specific approval of the Secretary of War. In fact, no large stocks of these agents have ever been accumulated.

Upon assumption by the War Department of full responsibility in this field, the Secretary of War appointed the director of War Research Service as his special Consultant on Biological Warfare and established the United States Biological Warfare Committee, with Mr. Merck as Chairman, to advise him on policy matters and to maintain close liaison with the British and Canadian groups concerned with biological warfare. This Committee was composed of representatives of the Chemical Warfare Service, the Office of the Surgeon General, U.S. Army; Bureau of Medicine, U.S. Navy; Bureau of Ordnance, U.S. Navy; Army Service Forces; Army Air Forces; New Developments Divider, War Department Special Staff; G-2; and the Office of Strategic Service. A new committee—designated the DEF Committee—was formed by the National Academy of Sciences and the National Research Council to advise the War Department on the scientific aspects of the subject.

At the height of its development, the Special Projects Division of the Chemical Warfare Service of the Army, which carried the main responsibility for the program after June of 1944, had a total personnel of nearly 3900, of which some 28000 were Army personnel, nearly 1000 Navy, and nearly 100 civilian. The projects carried on by the Special Projects Division at its four installations were combined operations with Army, Navy, and civilian personnel working together in the closest cooperation. They worked under high pressure and the strictest secrecy. Their achievements have been most remarkable.

The first installation established by the Special Projects Division in April 1943 was the parent research and pilot center in Maryland; the second, field testing facilities established in the summer of 1943 in Mississippi; the third, a plant designed for the investigation of larger scale production acquired early in 1944 in Indiana; and the fourth, field testing facilities established in the summer of 1944 in Utah. These installations were unique in many respects requiring, as they did, special designing to meet the completely new problems under investigation. The need for great precision and rigid safety requirements created many complex engineering problems. Special equipment had to be designed, constructed and installed to handle processes never before exploited and on a scale of operation never before undertaken.

While it is not possible to reveal at this time the specific agents on which intensive work was done at these installations, the general nature of the problem and the type of information that was obtained in this field can now be told. It should be emphasized that while the main objective in all these endeavors was to develop methods for defending ourselves against possible enemy use of biological warfare agents, it was necessary to investigate offensive possibilities in order to learn what measures could be used for defense. It was equally clear that the possibility of retaliation in kind could not be disregarded in the event that such agents were used against us. Accordingly, the problems of offense and defense were closely interlinked in all the investigations conducted. This is implicit in the discussion which follows.

A wide variety of agents pathogenic for men, animals, and plants was considered. Agents selected for exhaustive investigation were made as virulent as possible, produced in specially selected culture media and under optimum conditions for growth, and tested for disease producing power on animals or plants. Intensive investigations were conducted on many aspects of this field, including studies of how well various organisms of high-disease producing power would retain their virility and how long they would remain alive under different storage conditions; biological, physical and chemical protective measures; the numbers of organisms required to produce infection; the effectiveness of antibiotics and chemo-therapeutic agents; the incubation period of various diseases; and effectiveness of certain chemicals (or coagents) when used with pathogenic agents or toxins in influencing their disease producing powers. From these and other studies has come much new information which, when published in scientific journals, will make significant contributions to the advancement of knowledge. Extensive studies of biological and chemical agents which might have been used in attacking our crops resulted in certain discoveries which will undoubtedly prove of great value to agriculture.

Studies were made of methods and means by which biological warfare agents might be employed against us. This involved not only the perfection of anti-sabotage measures—information on which was made available to appropriate civilian and military authorities—but also studies of the various types of munitions that might be employed for the dissemination of biological warfare agents. A strong intelligence program was instituted which operated very effectively in all theaters of operation with the result that a thorough knowledge of German activities in this field was obtained. Similar investigations of Japanese activities are now being conducted. When these investigations are completed it will be possible to evaluate fully the work carried on in this field by our enemies. All evidence to date indicates that the Axis powers were behind the United States, the United Kingdom, and Canada in their work on biological warfare. It is known also that after early 1942 Germany obtained no information concerning the United States activity in biological warfare, and that no serious leaks of information on this subject occurred in this country. The intelligent and whole-hearted cooperation of the press and radio of the nation, working in conjunction with the Office of Censorship, helped very materially in this regard.

In all work on biological warfare carried on in the United States, extreme care was taken to protect the participating personnel from infection. Many new techniques were devised to prevent infection and proved highly successful. Hospitals and dispensaries were maintained at all installations, staffed with both Army and Navy medical personnel and well equipped to treat accidental exposure to infection. As the result of the extraordinary precautions taken, there were only sixty cases of proven infection and these were caused by accidental exposure to virulent biological warfare agents which required treatment. Fifty-two of these recovered completely; of the eight cases remaining, all are recovering satisfactorily. There were, in addition to the sixty proven cases, 159 accidental exposures to agents of unknown concentrations. All but one of these received prompt treatment and did not develop any infection. In one instance, the individual did not report exposure, de-

veloped the disease, but recovered after treatment.

Obviously none of these cases were brought about intentionally, and were not, therefore, "controlled" experiments, but in any event certain valuable information was obtained from their treatment, particularly with regard to new antibiotics, chemotherapeutic agents, and immunizing procedures, which, but for these cases of accidental infection, could otherwise have been tested only on animals. Considering the variety of pathogenic agents handled, the scale of operations employed, and the relatively large number of people involved, the safety record of our biological warfare program is truly remarkable.

The activities of the United States in the field of biological warfare, undertaken under the goad of necessity and aimed primarily toward securing for this nation and its troops in the field adequate protection against the possible use by our enemies of biological warfare agents, were carried on with that teamwork characterized by cooperative effort in wartime. The branches of the Army and Navy, many civilian scientists, university and private research institutions, and several Departments of the Government all worked together to the common end. This was a matter of great urgency, and many of the problems were unique and most complex. The objective was attained; adequate defenses against a potentially dangerous method of warfare were devised, the possibility of surprise from this quarter was forestalled. Apart from the military objectives attained, however, much information of greater and lasting value for human welfare was obtained. Unique facilities were established for research and experimentation on pathogenic agents on a scale never before possible. These facilities will be of inestimable value to future military and civilian biological investigations. In general terms, these were some of the more important accomplishments of the program:

1. Development of methods and facilities for the mass production of microorganisms and their products.

2. Development of methods for the rapid and accurate detection of minute quantities of disease-producing agents.

3. Significant contributions to knowledge of the control of airborne disease—producing agents.

4. Production and isolation, for the first time, of a crystalline bacterial toxin, which has opened the way for the preparation of a more highly purified immunizing toxoid.

5. Development and production of an effective toxoid in sufficient quantities to protect large scale operations should this be necessary.

6. Significant contributions to knowledge concerning the development of immunity in human beings and animals against certain infectious diseases.

7. Important advances in the treatment of certain infectious diseases of human beings and animals, and in the development of effective protective clothing and equipment.

8. Development of laboratory animal propagation and maintenance facilities to supply the tremendous number of approved strains of experimental animals required for investigations.

9. Applications of special photographic techniques to the study of airborne microorganisms and the safety of laboratory procedures.

10. Information on the effects of more than 1000 different chemical agents on living plants.

11. Studies of the production and control of certain diseases of plants.

Steps are being taken to permit the release of such technical papers and reports by those who have been engaged in this field as may be published without endangering the national security. It is important that this may be done soon, for much of the information developed in the course of this undertaking will be of great value to public health, agriculture, industry, and the fundamental sciences.

III

While it is true that biological warfare is still in the realm of theory rather than fact, in the sense that it has not actually been used, the military findings of groups engaged in similar work in the United Kingdom and Canada have shown that this type of warfare cannot be discounted by those of this nation who are concerned with the national security. Our endeavors during the war provided means of defending the nation against biological warfare in terms of its presently known potentialities, and explored means of retaliation which might have been used, had such a course been necessary. Although remarkable achievements can be recorded, the metes and bounds of this type of warfare have by no means been completely measured. Work in this field, born of the necessity of war, cannot be ignored in time of peace; it must be continued on a sufficient scale to provide an adequate defense.

It is important to note that, unlike the development of the atomic bomb and other secret weapons during the war, the development of agents for biological warfare is possible in many countries, large and small, without vast expenditures of money or the construction of huge production facilities. It is clear that the development of biological warfare could very well proceed in many countries, perhaps under the guise of legitmate medical or bacteriological research.

In whatever deliberations that take place concerning the implementation of a lasting peace in the world, the potentialities of biological warfare cannot safely be ignored.

How Can Atomic Energy Be Controlled?—

(Continued from page 15)

traditional ideals of science, and men eager to contribute to the increase and dissemination of knowledge regardless of national boundaries, will be glad to join this group." And this high caliber of talent would be essential to world security so that the agency entrusted with control would know as much as anyone in the world about new possibilities.

There is an even more important though perhaps less obvious reason why the agency should be more than a policing force. "To be genuinely effective for security," my associates and I stated in our Report, "the plan must be one that is not wholly negative, suppressive, and police-like . . . (It) must be one that will tend to develop the beneficial possibilities of atomic energy and encourage the growth of fundamental knowledge, stirring the constructive and imaginative impulses of men rather than merely concentrating on the defensive and negative. It should, in short, be a plan that looks to the promise of man's future well-being as well as to his security."

Some people have objected to our proposal because it doesn't guarantee an end to war. That's a valid criticism, for what we set out to do was to find a way to prevent the surprise use of atomic weapons. Everyone would be profoundly happy if someone would come up with a workable scheme that would eliminate all war with one stroke; but I don't anticipate that that's the way it will happen. That's the goal; it must be, of course; but to get to that goal we've got a long way to go and much to learn. Perhaps the best way to get there is to start with the most urgent problem, and that would seem to be atomic weapons. If we can't take this first step what chance is there for the full-blown world government some people believe is essential, or an end to all war? My own guess is, not much.

But if in this one field of atomic energy the people of the world can develop a system of world law and a world operating and control agency, by following the facts and disregarding political dogma, then perhaps all of us can tackle the next worst problem in the same way, and get that behind us, and on to the next, and in this way begin to work together, begin to figure out our problems on the basis of facts, in something of the spirit that scientists go about their problems, and really look forward to a generation of great progress and security, of real development not only physically, but morally and spiritually.

The Atomic Bomb and the Prevention of War

. . . . . *Bertrand Russell*

Mr. Russell in transmitting this manuscript wrote us an interesting note indicating that it had been refused by five American periodicals of wide circulation. (It has appeared in the English journal POLEMIC.) In offering it to the Bulletin —which he reads "with interest and attention"—Mr. Russell trusted us to cut it if necessary without distorting his views.

We publish the article in full in the belief that Mr. Russell automatically deserves an American audience and that the Bulletin reader is sufficiently discriminating to profit from articles which he does not necessarily endorse.

THE IMPACT OF ATOMIC WAR

The atomic bomb has set a problem to mankind which must be solved if any tolerable existence is to be possible for the human race. The problem is that of abolishing large-scale war, not at some distant future date, but quickly, before there has been time for another vast conflict to break out.

If the next great war were to occur within the next two or three years, it would probably lead to a quick victory for the United States and its allies, since no other Power would have atomic bombs. But if there is no war in the near future, there will have been time for Russia to manufacture atomic bombs—and not only Russia, but many other nations, great and small. It must be assumed that bombs will soon become much cheaper and much more destructive than those dropped on the Japanese. In addition to bombs there is the possibility of spraying large regions with radioactive substances which will exterminate all life in their neighborhood. Given a little carelessness, life on this planet may be made impossible.

It is to be expected that, if war comes, it will begin with a surprise attack in the style of Pearl Harbor. The aggressor will hope for a knock-out blow so severe as to make retaliation impossible. If Great Britain were the target, it is probable that this hope would be realized, for Great Britain is peculiarly vulnerable to atomic attack, owing to the smallness of its area and the density of its population. It is to be expected that during the first day or two London, Glasgow, and all the major centers of population will be wiped out; industrial production will be paralyzed, and about half the inhabitants will perish. To carry on the war after such a blow would be totally impossible.

The situation will be slightly less catastrophic, though still appalling, if the attack is directed against the United States. In the first 24 hours, New York, Washington, Chicago, and all the main centers of population will cease to exist; President and Congress will have undergone a diabolic alchemy, and a considerable percentage of the inhabitants of the United States, including most of those who are important in industry, will perish. The bomb will be borne by rockets, and it will be a matter of guess-work to infer what government is responsible. Some of the survivors will clamour for peace at any price, while others will proclaim that they would rather die than submit to so foul a blow. If the nation's store of atomic bombs has been succesfully safeguarded, probably the resisters will prevail; there will be fierce revenge, many nations will be drawn in, and destruction will continue until disorganization makes the further manufacture of atomic bombs impossible. If one side succeeds first in this aim, it may consider that it has won a victory, but it will be a "victory" far more disastrous to the "victor" than any defeat known to history.

THE COST OF "PREPAREDNESS"

Let us consider for a moment what will be involved in the meantime in safeguarding atomic bombs and rockets. It will be necessary to keep their location secret, which will mean virtually a prison camp for those who work in connection with them. It will involve a constant suspicion of treachery, leading to a prohibition of foreign travel for all but the most highly trusted public servants, as already in Russia. It will involve a complete cessation of freedom for all scientific workers whose activities have any bearing on the warlike utilization of atomic energy. It will require apparatus and crews always ready, day and night, to retaliate upon whoever is considered the most probable enemy, as soon as there is any report of an atomic bomb being dropped. These crews must be told that, in a crisis, they are not to wait for orders, since the statesmen and the higher command will probably be wiped out. In the atmosphere of mutual suspicion thus generated diplomats will meet to discuss such important questions as who is to have the oil of Persia or the tin of Malaya; as they talk, they will be wondering which side will get in first with its Pearl Harbor. Sooner or later, nerves will give way, and the explosion will occur.

If utter and complete disaster is to be avoided, there must never again be a great war, unless it occurs within the next few years. Is it possible to establish a system which will secure this result before we suffer the penalty of our folly and our cleverness?

THE PERMANENT PREVENTION OF WAR

It is entirely clear that there is only one way in which great wars can be permanently prevented, and that is the establishment of an international government with a monopoly of serious armed force. When I speak of an international government, I mean one that really governs, not an amiable façade like the League of Nations, or a pretentious sham like the United Nations under its present constitution. An international government, if it is to be able to preserve peace, must have the only atomic bombs, the only plant for producing them, the only air force, the only battleships, and, generally, whatever is necessary to make it irresistible. Its atomic staff, its air squadrons, the crews of its battleships, and its infantry regiments must each severally be composed of men of many different nations; there must be no possibility of the development of national feeling in any unit larger than a company. Every member of the international armed force should be carefully trained in loyalty to the international government.

The international authority must have a monopoly of uranium, and of whatever other raw material may hereafter be found suitable for the manufacture of atomic bombs. It must have a large army of inspectors who must have the right to enter any factory without notice; any attempt to interfere with them or to obstruct their work must be treated as a *casus belli*. They must be provided with aeroplanes enabling them to discover whether secret plants are being established in empty regions near either Pole or in the middle of large deserts.

The monopoly of armed force is the most necessary attribute of the international government, but it will, of course, have to exercise various governmental functions. It will have to decide all disputes between different nations, and will have to possess the right to revise treaties. It will have to be bound by its constitution to intervene by force of arms against any nation that refuses to submit to the arbitration. Given its monopoly of armed force, such intervention will be seldom necessary and quickly successful. I will not stay to consider what further powers the international government might profitably possess, since those that I have mentioned would suffice to prevent serious wars.

PEACE THROUGH POWER ALLIANCES

There is one other method by which, in theory, the peace of the world could be secured, and that is the supremacy of one nation or of one closely allied group of nations. By this method Rome secured the peace of the Mediterranean area for several centuries. America at this moment, if it were bellicose and imperialistic, could compel the rest of the world to disarm, and establish a world-wide monopoly of American armed forces. But the country has no wish for such enterprises, and in a few years the opportunity will be gone. In the near future, a world war, however terrible, would probably end in American victory without the destruction of civilization in the Western hemisphere, and American victory would no doubt lead to a world government under the hegemony of the United States —a result which, for my part, I should welcome with enthusiasm.

But if, as seems more likely, there is no world war until Russia has an adequate supply of atomic bombs, plans for world peace will have to reckon with Russia and America as roughly equal Powers, and an international government, if it is to be established before the outbreak of an utterly disastrous war, will have to be created by agreement rather than by force.

Short of actual force, however, the government of the United States, with the support of Great Britain and a number of other Powers, could do a great deal towards the creation of an international government. An alliance could be formed, consisting in the first place of all North and South America, the British Commonwealth, France, Belgium, Holland, Scandinavia, and Spain (after dealing with Franco). This alliance should proclaim certain international purposes, and declare its willingness to be joined by any Power that subscribed to those purposes. There should be both military and economic inducements to join the alliance: military, in that the alliance as a whole would undertake the defense of all its members; economic, in a lower tariff for trade within the alliance than for trade with countries outside it, and also in advantages as regards loans and access to raw materials. There should be a gradual increase in the closeness of the alliance, and a continually greater amalgamation of military resources. Every possible effort should be made to induce Russia to become a member the alliance. In this way international government might grow up gradually.

PEACE THROUGH THE UN

There is, however, a strong body of opinion which favors a different course. Instead of trying to create a strong organization which would at first not include Russia, those who favor this opinion prefer a weak organization, the United Nations, of which Russia is already a member. If this is to be anything more than a weak evasion of the problem, it must be supplemented by a vigorous attempt to alter the constitution of the United Nations. At present, there is machinery for preventing Finland from attacking Russia, but none for preventing Russia from attacking Finland. There is, in fact, nothing to hinder a Great Power from waging aggressive war, whether against another Great Power or against a small defenseless neighbor. The only wars prevented by the organization of the United Nations are those that are not at all likely to occur.

If the United Nations Organization is to serve any useful purpose, three successive reforms are necessary. First, the veto of the Great Powers must be abolished, and majorities must be declared competent to decide on all questions that come before the organization: second, the contingents of the various Powers to the armed forces of the organization must be increased until they become stronger than any national armed forces; third, the contingents, instead of remaining national blocks, must be distributed so that no considerable unit retains any national feeling or national cohesion. When all these things have been done, but not before, the United Nations Organization may become a means of averting great wars.

All this may seem Utopian, and perhaps it is. Politicians and diplomats are trained in evasion and ambiguity; most of them will prefer to offer a sham which can be obtained with little effort rather than an effective measure that is sure to encounter strenuous opposition, but they will dress up the sham so skillfully that many people will be deceived. Those to whom the survival of mankind is more important than victory in the next election must strive to enlighten the public while there is still time, and perhaps we can succeed.

The men of science, to whom politics is an alien art, find themselves suddenly faced with great responsibilities which they do not know how to fulfill. By their discoveries they have put immense powers, for good or evil, into the hands of ordinary men who have not the training required for a rapid change in age-old mental habits. The political world is complex, and understanding nuclei is no help in understanding diplomacy. But the same intelligence which enabled physicists to understand nuclei will enable them to understand politics, provided they realize that the problems are complex and that slap-dash solutions will not work.

"THE BIG TWO"

Although people speak of the "Big Three" or the "Big Five", there are in fact two Powers, the United States and the U.S.S.R., which far surpass all others in strength. Other Powers are, some of them, satellites of the one, some of the other, some hesitantly neutral. All other important Powers, including Great Britain, are, I think, prepared to acquiesce in the limitations of national sovereignty that are called for by the atomic bomb. This is not owing to any superior wisdom, but because their national sovereignty is already at the mercy of the Big Two. (E.g. the British have to submit to Bretton Woods and the Chinese, unless vigorously supported by America, to the loss of Port Arthur and the South Manchurian Railway.) The problem of establishing an international authority is therefore a problem of which the solution rests with America and Russia.

Russia, since it is a dictatorship in which public opinion has no free means of expression, can only be dealt with on the governmental level. Stalin and Molotov, or their successors, will have to be persuaded that it is to the national interest of Russia to permit the creation of an effective international government. I do not think the necessary persuasion can be effected except by governments, especially the government of the United States. Nor do I think that the persuasion can be effected by arguments of principle. The only possible way, in my opinion, is by a mixture of cajolery and threat, making it plain to the Soviet authorities that refusal will entail disaster, while acceptance will not.

THE EDUCATIONAL TASK IN AMERICA

Persuasion in the United States, where there is freedom of propaganda, is a different matter. If things do not go as we might wish, the fault is usually not with the politicians, though they get the blame; the fault is with public opinion, to which the politicians, as democrats, quite legitimately give way. What is needed is an immense campaign of public education. The average American voter, very naturally, is annoyed by the way in which the follies of Europe and Asia compel America to go to war; in his emotions he is an isolationist, even when hard facts have convinced his reason that isolationism is no longer practicable. He wishes the Atlantic were still as wide as in Washington's day, and is

apt to forget the arguments against isolationism whenever business is prosperous.

To meet this difficulty it is necessary to bring home, not only to administrators or Congressmen, but to the average American citizen, the dangers to which, within a few years, America will be exposed, and the impossibility of warding off the dangers except by a partial surrender of sovereignty. The first reaction of nine people out of ten will be to urge that America should have more bombs than any one else, so that an attack by any other nation would be obviously folly. The fallacy in this point of view must be made plain to all and sundry. It must be pointed out that America has already been involved in two world wars as a direct result of the fear of being involved: both in 1914 and in 1939 Germany would not have gone to war if America had pronounced in advance against neutrality. It must be made clear that the same thing would inevitably happen again: a war between Russia and China, or between Russia and Great Britain, would be sure to involve the United States. Next, the utter disaster of an atomic war must be made clear, and it must be demonstrated that there is no defense against a surprise attack. Finally it must be proved that there is no hope in Kellogg Pacts, declarations of universal good will, alliances, or paper prohibitions of the use of atomic bombs. All this must be set forth in speech and in writing throughout the length and breadth of the land, by men having no motive except public spirit and the hope that the world in which they have lived may still exist in their children's time.

If such a campaign is to succeed, it requires three things: a definite programme, an organization, and the enthusiasm of a great moral crusade. Without this last nothing can be achieved, for although, from a purely rational point of view, self-preservation is a sufficient motive for all that needs to be done, self-preservation alone will not overcome the obstacles of rational thinking that are presented by ancient habits of hatred, suspicion, and envy. We shall have to realize that what injures a foreign nation does not necessarily benefit our own. We shall have to learn to feel a little uncomfortable if we wallow in plenty while millions die of hunger and cold. We shall have to feel that domination brings less happiness than cooperation, and that mutual hostility, which was always wicked, has now become suicidal folly.

But I would not have it thought that our campaign should be mainly negative, or based entirely upon an appeal to fear. The appeal to fear has its function, especially in providing an initial shock which may compel attention. But the ultimate and most valid appeal should be to hope. There is no need of great wars, no need of the horror of populations reduced to utter misery, harried and starved in a vast campaign of retribution. There is no reason why poverty and want should continue anywhere in the world. There is no reason why national education, in almost every country, should encourage false beliefs which promote warlike feeling. There is no reason why increase in the efficiency of production should be used, not to raise the standard of life, but to increase the proportion of human effort that is devoted to mutual extermination. All these evils depend for their continued existence upon war, and the national hostilities bred by the fear of war. If once the fear of war were removed, the whole human race could quickly attain a level of happiness and well-being surpassing that of the most fortunate in any earlier time. If the atomic bomb shocks the nations into acquiescence in a system making great wars impossible, it will have been one of the greatest boons ever conferred by science.

But it is time to return from these high hopes to the very different world in which for the present we have to live. I shall assume that such a campaign as I have indicated has had a considerable measure of success in America and Great Britain. (It will encounter less opposition in Great Britain, because the British realize that Great Britain will be wiped out in the next great war, if it occurs.) It remains to ask ourselves what, in that case, we ought to do about Russia.

ANGLO-AMERICAN POLICY TOWARDS RUSSIA

The policy most likely to lead to peace is not one of unadulterated pacifism. A complete pacifist might say: "Peace with Russia can always be preserved by yielding to every Russian demand." This is the policy of appeasement, pursued, with disastrous results, by the British and French Governments in the years before the war that is now ended. I myself supported this policy on pacifist grounds, but I now hold that I was mistaken. Such a policy encourages continually greater demands on the part of the Power to be appeased, until at last some demand is made which is felt to be intolerable, and the whole trend is suddenly reversed. It is not by giving the appearance of cowardice or unworthy submission that the peace of the world can be secured.

In dealing with the Soviet Government, what is most needed is *definiteness*. The American and British governments should state what issues they consider vital, and on other issues they should allow Russia a free hand. Within this framework they should be as conciliatory as possible. They should make it clear that genuine international cooperation is what they most desire. But although peace should be their goal, they should not let it appear that they are for peace at any price. At a certain stage, when their plan for an international government are ripe, they should offer them to the world, and enlist the greatest possible amount of support; I think they should offer them through the medium of the United Nations. If Russia acquiesced willingly, all would be well. If not, it would be necessary to bring pressure to bear, even to the extent of risking war, for in that case it is pretty certain that Russia would agree. If Russia does not agree to join in forming an international government, there will be war sooner or later; it is therefore wise to use any degree of pressure that may be necessary. But pressure should not be applied until every possible conciliatory approach has been tried and has failed. I have little doubt that such a policy, vigorously pursued, would in the end secure Russian acquiescence.

THE CONSEQUENCES OF FAILURE

The issue is the most momentous with which mankind has ever been faced. If it is not solved, war will exterminate the civilized portion of mankind, except for such remnants as may have been engaged in exploring the Antarctic Continent or investigating the theology of Tibetan Lamas. These will be too few to reestablish civilized communities. If mankind, in the course of a millenium or two, slowly climbs back to its present intellectual level, it is to be presumed that it will again inflict a similar catastrophe upon itself. If any of the things that we value are to survive, the problem must be solved. How it can be solved is clear; the difficulty is to persuade the human race to acquiesce in its own survival. I cannot believe that this task is impossible.

The Medical Uses of Atomic Energy . . . . . C. P. Rhoads

What can we accomplish today in the application of radioactive isotopes in the treatment of disease? My feeling is that, at this moment, isotopes of only two elements have been proved to be therapeutically useful: radioactive isotopes of iodine and phosphorus.

Curiously enough, each one of these two elements has been shown to be useful in the treatment of one non-cancerous medical disorder and one form of cancer. That is, radioactive iodine has been proved to be effective in the treatment of a disorder of the thyroid gland associated with over-functioning of that gland and poisoning of the body. Radioactive iodine is capable of restraining this overactivity, bringing functions to normal and so relieving the patient of symptoms. The application of iodine in the treatment of cancer of the thyroid gland I will discuss in a moment. In the case of phosphorus, there is a very real use in treating a non-cancerous disorder of the blood-forming tissues, a disorder marked also by over-functioning, which can be restrained by the use of radioactive phosphorus. There is also a set of cancerous disorders of blood formation known as leukemia, which again can be restrained in certain specific instances.

I will discuss the matter in that order, the two medical applications of radioactive phosphorus.

The work with iodine began in a rather quiet way in the late 1930's, and one of the earliest studies was that of Hertz and his associates in Boston, who prepared iodine by the exposure of ethyl-iodide to radium mixed with beryllium. The activated iodine was injected into rabbits. Then the various organs of the recipient animal were removed, minced, spread in a mush on a plate, and exposed to standard detection techniques. In this way it was possible to show that, as had been expected, the thyroid gland picked up, when normal, about 80 times as much iodine as was picked up by any other normal tissue. This result is still valid. Furthermore, the fact was shown that, if the thyroid gland was stimulated by such factors as pregnancy or else by the administration of materials which lead to over-activity of this gland, the pick-up of iodine might reach a level of several hundred times that found in normal tissue.

I don't wish to oversimplify, but perhaps it is appropriate to explain that the thyroid gland is located in the neck and had the very important function of selecting iodine from the blood stream and of converting the iodine to a compound known as thyroxin, which is active in maintaining a specified rate of —the rate of oxidation of live tissues— oxidation of the tissues. When an excess of thyroxin is formed, the metabolic rate increases to a point where severe symptoms of poisoning and death may result. This disease can be controlled in many instances by the removal of the source of the poison, the thyroid gland or a large part of the gland. This involves a procedure which is at best troublesome and unpleasant; at worst hazardous —possibly to a great degree. Hence, any procedure which allows the control of over-thyroid function without surgical operation is a matter of great importance to medicine.

The experiments of Hertz showed not only that the active thyroid gland picked up more iodine than the normal thyroid gland, but also that the curve of pick-up was quite different. Furthermore, certain different types of overactivity could be elucidated specifically by examining the rate of uptake of iodine in these beautiful experiments. Once these points had been clear, the next logical step was to use iodine, prepared by the cyclotron method and then becoming available, to study the uptake of iodine by the thyroid gland of human beings.

A good deal of very complex work was involved. Precise indexes had to be established by which the pick-up per unit of tissue could be settled. This was done and then studies were made on man. The earliest set of reports or one of the earliest was by Hamilton and Soley of the University of California; a report by Hertz appeared about the same time.

Hamilton reported on 22 patients in 1939, 22 patients with overactivity of the thyroid gland treated by radioactive iodine and studied for the extent of the pick-up of this active element by the thyroid tissue. He made a very important observation, later confirmed by Hertz, that the iodine actually goes to form the toxic material which is made by this gland. In other words, the iodine takes part in the natural metabolic processes of this important organ; this fact is a notable contribution to our knowledge.

Furthermore, Hamilton reported on two patients who had cancer of the thyroid gland. The evidence suggested that the cancer shared the ability of the tissues from which it sprang to pick up iodine. The findings, of course, led to the possibilities that one had (a) a method for controlling overactivity of the gland and (b) a method of controlling, perhaps, cancer of the gland.

I will deal with overactivity first. In the spring of this year, two papers appeared from the Boston investigators, one by Hertz and Roberts and the other by Chapman and Evans, who picked up the work when Hertz left for the war. These papers deal with the results of the study of some 50 patients with thyroid overactivity. Detailed studies were made, the precise retention of iodine by the gland was established, and the precise degree of control of gland activity was made clear and factual. It is possible to say that today, on the basis of well established data, this disorder may be controlled in about 80 percent of the patients by giving radioactive iodine. This is a very important advance.

I am sorry to say that one precaution was not observed, as far as I am aware. I am not certain that sufficient experiments have been done to establish the limits of safety of the use of radioactive iodine in the treatment of thyroid disorders. One must always recall that, in dealing with materials of this type, sufficient energy may be liberated over a sufficiently long period to make cancer occur. It is a very curious anomaly that the agents with which we deal in treating cancer are also under certain circumstances able to cause cancer. I am very hopeful that studies will be made now on an extensive scale to establish the amount of radiation delivered by iodine to the thyroid gland which can be tolerated without the induction of changes which may become cancer in that organ.

In short, one can control hyperthyroidism by the use of radioactive iodine. There is a little debate about what dose is desirable and a little debate upon the duration of control, but I think for the purpose of a general statement one can assume that the case is proved and control is possible.

The use of radioactive iodine in the treatment of thyroid cancer is a much more difficult matter, and I think I am justified in discussing for a moment what we know about the nature of cancer. Recall that cancer is the growth from a normal cell of a distinctly abnormal one which shares in appearance, structure, and functions certain of the characteristics of the cells from which it sprang, but which differs somewhat from the parent structure. These differences can be established in a variety of ways and they may be of greater or lesser degree. We have no really precise means for measuring how different the functions of the cancer cell are from its maternal parent.

Thyroid cancer is more than a single disease. This disorder, marked by a wild, uncontrolled overgrowth of thyroid

gland cells, may take a variety of forms discernable under the microscope. Mr. Marinelli and Dr. Foote of Memorial Hospital, among others, have made careful studies of the quantitative pick-up of radioactive iodine by the several forms of cancer of the thyroid gland, and also by certain non-cancerous or benign tumors of that organ. They have done a great deal to correlate the cellular picture of thyroid cancer with its ability to pick up iodine. It is a very interesting thing that, as the cancer cells become more and more unlike their parent cells, they simultaneously lose to a greater and greater degree the ability to share with the parent cells the function of selecting iodine and concentrating it in their bodies. In other words, the more malignant, the more vicious, the more widespread and destructive the cancer is, the less, by and large, is its ability to pick iodine out of the blood stream and to concentrate it in the cellular structure.

It happens that some years ago at the Montefiore Hospital here in New York two patients were studied who had cancer of the thyroid gland and had very extensive localized deposits of the cancer tissue in various parts of the body far removed from the parent tissue—what we call metastases. Of these two patients, one had had the thyroid gland, the site of the original cancer, removed surgically but still had manifestations of an overactivity of the thyroid. This was clear evidence, of course, that the extensions of this cancer shared the functions possessed by the parent gland of manufacturing thyroxin, the toxic product formed by the gland normally. This suggested that, since thyroxin contains iodine, the cancer metastasis or localized deposits would pick up radioactive iodine and perhaps in sufficient quantities to allow control of the growth.

Indeed, in this instance, when iodine was given as a tracer and a Geiger counter passed over the body, deposits of cancer were detected which had not been visualized by ordinary x-ray methods. Allow me to point out that this was a very unusual case and a beautiful one for experimental study. I believe that Mr. Marinelli, Dr. Leiter, Dr. Seidlin, and their associates made a very distinguished contribution. It was possible to show that the conventional method of supressing the thyroid activity in this patient also suppressed the activity of the localized disseminated deposits of the thyroid cancer, and further that the iodine was picked up in good concentration by these localized deposits. Then finally the crucial experiment was made under Mr. Marinelli's direction: the patient was treated with radioactive iodine and a pronounced therapeutic effect was obtained. Indeed, now some years later, the patient still appears to be under good control. The tumor is still there but, as far as one can tell, it is no longer active. A very dramatic and a very exciting case. However, this point must be made, thyroid cancer takes many forms. Certainly not more than 15 percent of all thyroid cancers, a rare desease in the first place, has been shown to pick up appreciable amounts of radioactive iodine. One form, and a rather unusual form, can be depended upon to pick up iodine. The more malignant and destructive forms tend to pick up to a lesser and lesser degree as the inasiveness increases.

I personally cannot feel hopeful that we will have by radioactive iodine, straight inorganic iodine, an attack on a very large percentage of thyroid cancers. The beautiful work done on the single case I have discussed with you and the excitement associated with any new method of treatment have tended to obscure the fact that only a very small percentage of all thyroid cancers pick up radioactive iodine at all and only a very small fraction of those pick up amounts adequate to allow one to expect to control the disease.

However, I don't wish to appear overpessimistic. I'd like to point out that we have only scratched the surface of this problem. Efforts should be undertaken to incorporate radioactive iodine in organic compounds that may be picked up to a greater extent by the abnormal, cancerous tissue.

To summarize, radioactive iodine is useful in the treatment of hyperthyroidism, but I think that we do not yet have adequate data on the hazards. Therefore, until we have more information, I will preserve a conservative position in predicting the extent of the future use of that material. In the treatment of thyroid cancer, only a small percentage of the cancers pick up iodine at all and only a small fraction of those pick up enough to allow us to expect a therapeutic effect of the radioactive element. But still the first bridge has been crossed; one can control specific examples of the disease.

I will next discuss radioactive phosphorus. Early in the work with isotopes, Dr. John Lawrence of the University of California and others began to explore the possibility that phosphorus could be used to measure the rate of growth or the rate of chemical turnover of normal and cancer cells. This of course was thought possible because phosphorus is an active participant in the metabolic processes.

Dr. Lawrence published originally a very dramatic experiment involving the use of radioactive phosphorus in the study of leukemia in mice. I'd like to point out that leukemia is a term which includes a number of sub-groups. It is a cancer of the blood-forming tissues but, since there are several different types of blood-forming tissues, there are several different types of leukemia. They are all fatal, but they vary in their clinical manifestations and in their response to therapy.

The results obtained by Dr. Lawrence proved that the lymph glands, the glands in one's neck that swell when one has a sore throat, if they were the site of cancer (leukemia), picked up more radioactive phosphorus than did the normal glands. That led to an elaborate series of studies on animals with leukemia of various forms and then on human beings with leukemia to establish how great a difference in pick-up existed between normal tissue and tissue which had become cancerous (leukemic). It was learned that the pick-up of phosphorus was dependent really upon a number of factors. One factor is the amount of phosphorus which normally is deposited in tissue. For example, bone, which is made up very largely of calcium phosphate, will in time deposit a large amount of radioactive phosphorus, but it is turned over very slowly. This leads to a second factor, the metabolic turnover of phosphorus, and that is very important because rapidly growing cells use in their metabolic activity much more phosphorus than do less actively growing cells.

Cancer cells, by and large, are very rapidly growing cells, and so the very early observations gave very promising results. They indicated clearly that cancer cells in general tended to pick up more phosphorus per cell than did analogous normal cells. I regret to say that these early experiments in my opinion were not adequately controlled, because normal tissue was not compared with cancer tissue having the same rate of growth. The cancer tissue was compared with normal tissue of a lesser rate of growth. Since this factor of growth rate was not adequately controlled, the early figures were more hopeful than the later information warrants. But, in any event, the fact was clear that phosphorus was picked up by leukemia tissue. The pick-up depended on the chemical activity of the cells, the activity in general correlated with the rate of growth, and the cancer in general grows more rapidly than normal tissue; hence there was more phosphorus in the cancer cells than in the normal ones. This was particularly true of the cancer cells of the blood-forming tissues; the bone marrow, the spleen, and the lymph glands.

These facts promptly led, of course, to experiments designed to cure cancer of blood-forming tissue by the use of radioactive phosphorus. I don't want to bore you by a long dissertation on medical terminology, but you should understand

that there are two types of cancer of blood-forming tissue. One type concerns a group of white blood cells, normally the defensive cells of the blood stream, formed principally in the bone marrow. A cancer of these cells can occur, known as myelogenous leukemia. The cells then grow without restraint, infiltrate all tissues of the body, and lead to the death of the individual affected. These cancer cells share with the normal form the property of picking up large amounts of radioactive phosphorus or, of course, phosphorus of any type and are somewhat more active in this function. In this way, a high concentration of radioactive phosphorus can be set up in the cancer cell, which thereby poisons itself and commits suicide very handily for us. So far, some 150 patients have been treated for this disease with radioactive phosphorus.

To sum up the results, it may be stated that rather uniformly the growth of the cancer cells can be restrained to some extent, the symptoms of the patient can be lessened, but life probably is not prolonged. Certainly life is not prolonged by more than 2 or 3 months. The phosphorus is somewhat better from the point of view of the patient than is the use of conventional x-ray treatment, because there is less radiation sickness involved, but a real hazard is associated with the use of phosphorus. We are dealing here with an element with a half life of 14 days, and it is not possible to predict precisely how sensitive are the cancer cells or exactly how much phosphorus they will pick up. It is almost impossible to predict percisely how much normal blood-forming tissue is present in the body. Therefore, it is hard to arrive at a dose which is just right to control the cancer cells and will avoid serious or perhap fatal damage to the normal blood-forming tissues of the body. For that reason, a tendency in most institutions is to discard the use of phosphorus and to stick to conventional x-ray as being somewhat safer and more predictable in its results and attended by less hazards to the patient, even though it does cause some illness in the course of treatment.

The second form of leukemia, known as lymphatic leukemia, is a cancer of another type of white blood cells. It also kills uniformly and somewhat more quickly than does the myelogenous form. It is of particular concern to us all because it is a form which frequently effects children. There have been extensive studies on the use of radioactive phosphorus in the treatment of lymphatic leukemia, and I regret to say that the results are not promising.

About 160 patients have been studied carefully, and the results have been summarized. These experiments have been made in a number of clinics, all very good, and it is quite apparent that the results are rather unsatisfactory. Of all the patients with the chronic form of lymphatic leukemia only about 50 percent show any measurable benefit from this procedure. The other 50 percent are not benefited at all. Furthermore, the benefit exerted is at best transient since there is little or no prolongation of life. And, finally, there is a factor of hazard. Radioactive phosphorus, once it is in the body, can't be removed. The precise sensitivity of the normal tissue, which picks up phosphorus almost as well as the cancer tissue, cannot be predicted. The tendency is to abandon the use of radioactive phosphorus and to revert to the more conventional x-ray treatment. Even though the x-ray treatment requires cumbersome equipment and is associated with some illness on the part of the patient, it is somewhat more controllable.

I think that, until we have better compounds of radioactive phosphorus than those now used, the treatment of chronic lymphatic leukemia does not promise dramatic results in the near future. In the treatment of acute lymphatic leukemia, there is no good result whatever and it is distinctly hazardous.

To summarize briefly, there are two forms of leukemia; in myelogenous leukemia, some relief can be obtained, life is not prolonged, and there is little advantage in the use of phosphorus; in lymphatic leukemia, there is no advantage in phosphorus, life is not prolonged, and the hazard is real. I am not optimistic about the future of the use of inorganic radioactive phosphorus in the treatment of cancer of the blood-forming tissues.

There is another disorder of blood-forming tissues which is not a cancer and which is known as polycythemia. In this condition, the formation of red-blood cells is abnormally rapid. It is not a fatal disease. It is a metabolic abnormality attended by serious symptoms, great disability, and eventual complications which may lead to death. Here the picture is quite different from that of leukemia. In the case of polycythemia, radioactive phosphorus is an excellent therapeutic agent. Doses in the range of 2 to 4 millicuries result in the disappearance of symptoms, which lasts for up to two years without further treatment. The patient is enormously relieved. There is objective evidence of improvement and, by every point of view, in treating this disorder the use of radioactive phosphorus is the method of choice.

Let me sum up these four conditions. The two non-cancerous conditions—hyperthyroidism and polycythemia—are accessible today to treatment, the first with radioactive iodine and the second with radioactive phosphorus. The two cancerous conditions—thyroid cancer and cancer of blood-forming tissues—are not proved to be very accessible to cure or to control by the use of radioactive iodine in the first case or of radioactive phosphorus in the second case.

Now what does the future hold?

To have expected inorganic elements to be picked up so selectively and concentrated so adequately by cancer tissue as compared to normal tissue was a very optimistic hope. I am not surprised that we are somewhat disappointed, but we have a vast field before us. We are beginning to study the selective pick-up by cancer of a vast variety of organic compounds which can be synthesized in the laboratorie of organic chemistry to contain radioactive isotopes of a variety of elements. I am very hopeful—that startling discoveries will be made in the years to come—not next year or the year after, but in five, ten or fifteen years.

I can give you examples of what sort of thing is in progress. It is possible that cancer tissue contains somewhat different proportions of amino acids than does normal tissue. Experiments are under way to synthesize amino acids containing radioactive elements. It could be hoped, if one cares to be very optimistic, that one could in this way lead into the cancerous tissue, by its affinity for certain organic constituents, quantities of radioactive materials which would lead to an auto-intoxication and death of the cancer tissue. Similarly, much cancer occurs in organs which are under the control of the sex hormones, the breast and the uterus in women and the prostrate gland in men. These organs depend for their very existence an compounds of known chemical constitution. It is believed that they selectively concentrate these compounds or hormones when they are administered. Efforts are now under way to synthesize in the laboratory sex hormones containing radioactive elements.

Finally, and this must not be overlooked there is the tremendous fundamental work which will be done in a study of the basic biochemistry of the body by the use of radioactive tracer elements. I feel there has been far too much emphasis on the direct therapeutic application of the isotopes now in existence and far too little emphasis on the enormous developments out of which will come a new era of knowledge of the fundamental chemical processes of the body through the use of tracer elements which atomic energy provides. Through that study a vista opens up which is really most inspiring to think about.

Atomic Research in France

. . . . . *L. Kowarski*

The French Atomic Energy Authority ("Commissariat a l'Energie Atomique") was created early in 1946 by a special law promulgated by the Provisional Government. Roughly equivalent to an Undersecretaryship of State, it has wide powers to deal with all aspects of research, development, property and management within the field of fissile materials and nuclear energy. It is headed by a Commission consisting of a High Commissioner (at present: Professor Frederic Joliot, of the College de France), three scientfic Commissioners (Professors Pierre Auger, of the Ecole Normale Superieure, Irene Curie-Joliot, of the University of Paris and Francis Perrin, of the College de France) and a Commissioner representing National Defence (General Dassault, coordinator of defence research). Some of the Commission's meetings are held under the chairmanship of the Prime Minister and a permanent representation of the Government is secured by the presence of an Administrator-Delegate (at present: Raoul Dautry, former Minister of Supply and well-known administrator of French National Railways).

The overwhelming predominance of the civilian element among those responsible for atomic development in France is well in keeping with the aims of this development. According to the official statement made on June 25th by the French delegate at the UN Atomic Energy Commission, France has no intention of manufacturing atomic weapons. The intentions which prompt the French Government to undertake and sponsor atomic research may be listed as follows:

1) To enable French science, pure and applied, to bring her original contribution towards a worldwide development of atomic knowledge and its peaceful applications;

2) To create a pool of French scientists and engineers conversant with the basic facts and notions in the field of nuclear chain reactions and ready to make use of the new processes, wherever discovered and whenever disclosed;

3) To provide physical, chemical, biological and medical laboratories with new tools, including home-made tracers and radiotherapeutic substances;

To promote industrial uses of the energy derived from nuclear reactions, especially in the coal-importing regions of the French Union.

During the initial stages educational and fundamental research activities are likely to play a predominant role and, accordingly, an important part of the Authority's activity is at present exercised through the established research centers such as the Laboratory of Nuclear Chemistry (College de France), Radium Institute, etc. In order to facilitate and supplement the contribution of these older institutions, a cluster of workshops, testing laboratories and designing offices has been built up and is already in operation in a disused military fort in the immediate vicinity of Paris. The next step, at present in its preparatory stage, will be the establishment (on a site totalling several hundred acres in the outer suburban region south of Paris) of a full-scale new research center comprising at least one experimental pile, a radiochemical plant, accelerating equipment and facilities for applying radiations and radioactive substances in various branches of scientific research. Contracts have been concluded with industrial firms in France and abroad for the supply of specific raw materials and, at the same time, wide survey of resources in fissile elements is being conducted in the territories of the French Union, both metropolitan and overseas.

The Authority started its work with an initial endowment of 500 million francs ($4,200,000) to be followed by new grants according to the needs and pace of its development. Current figures concerning the rate of expenditure and size of the staff are hardly significant in the present stage of quick initial growth.

In appraising France's chances of playing a significant part in the worldwide search for atomic knowledge and of developing industrial nucleonics on her own territory, we have to bear in mind the handicaps resulting from the situation during the War and from the necessity to direct a very predominant part of the national effort towards the immediate needs of reconstruction. On the credit side, however, we may list a well-developed tradition of nuclear science, especially in the field of radiochemistry, the familiarity with many relevant industrial processes, such as non-ferrous metallurgy and electrochemistry and finally the facts that research on uranium fission was partly initiated in France, and that French scientists took an active part in the Allied research project all through the war years (as related in the British White Paper). Both because of these past links and in view of her intentions concerning the future, France has no isolationist tendencies in the field of atomic development. Her action with regard to such questions as secrecy and security against atomic weapons will be conditioned by her own views as well as by her past, present and future international obligations.

SUMMARY OF COUNCIL SESSIONS OF THE FEDERATION OF AMERICAN SCIENTISTS, N. Y. City, Sept. 22, 23, 1946

In a two day session, the Council of the F.A.S. elected officers and voted to:

Set up an International Information Center, probably in New York.

Study detailed plans for establishing an educational organization. Institute specialized study projects on topics related to atomic energy.

Invite persons outside the natural sciences to membership on the Advisory Panel of F.A.S.

The Sunday morning session afforded an opportunity for discussion with a group including Professor Blackett, President of the British Association of Scientific Workers; Drs. F. Joliot-Curie, and L. Kowarski of the French delegation to the U.N. Atomic Energy Commission; Dr. J. R. Oppenheimer; Drs. Szilard, Urey, and Weisskopf, of the Emergency Committee of Atomic Scientists; and Capt. Raymond Blackburn, M.P., who has taken an active interest in the political problems of atomic energy in Britain.

Comments on the negotiations in the U.N. Commission revealed agreement on the fundamentals of the problem, although difference of opinion exists on the implications of the U.S. Proposals, the feasibility of discussing the functions of an A.D.A. apart from the political aspects of its establishment, and the possible effect of the U.S. ceasing to manufacture bombs.

Boorse reported that the British atomic scientists have asked that the F.A.S. take the initiative in establishing an International Information Center, probably in New York. J. A. Simpson, H. A. Boorse, H. H. Goldsmith, and W. A. Higinbotham were named as a committee to make recommendations on carrying out this project.

The need for intensive studies by experts of special problems related to the program of the Federation was formally recognized. David Hawkins was authorized to name two others to serve with him as a commission to conduct such studies through the cooperation of appropriate specialists. Two topics were assigned for immediate attention: Present trends in the natural sciences; and the implication of the idea of preventive war.

In order to clarify its official structure, the F.A.S. voted to distinguish between the duties of Chairman of the Administrative Committee and those of supervising the central office by creating the title of Exec. Secy. for the latter function. For a similar reason, it combined the offices of Secy. Treas. R. R. Wilson was elected Chairman of the Administrative Committee; W. A. Higinbotham, Exec. Secy.; and J. H. Rush, Secy.-Treas.

— J. H. Rush

The Pattern of an Armaments Race—

Part II—An Analysis of Nationalism . . . . . *Gregory Bateson*

The whole of the foregoing discussion of armaments races is based upon the assumption that the population of the world is subdivided into a series of self-maximating units, called nations. It is clear that any blurring of the line of this subdivision, any union of these units under some central agency, or any steps which will diminish the self-maximating tendencies of the units will also diminish the possibility of international war as we understand it. It is also clear that any context which promotes the expression of international rivalry—not only the armaments race itself but also most of the competitive contexts of international negotiation—will increase the possibility of war.

There is, therefore, a series of matters which require careful analysis. Of these, we will here consider only two: 1. The mechanics of national self-maximation; 2. The mechanisms of central authority which are to be found in various parts of the world. These we shall examine to determine the conditions under which such authority is stable, so that we may make recommendations for the organization of a still higher authority which shall also be stable.

THE MECHANICS OF NATIONAL SELF-MAXIMATION

Here again, as in the armaments races, we have to deal with regenerative or "vicious" circles of causes and effects. The simplest of such circles was pointed out long ago by Malthus and consists in this, that the offspring which are the *effects* of procreation in one generation become the *causes* of procreation in the next. From this circular system it follows that if the offspring are consistently more numerous than the generation preceding, the population will show geometric increase. Such circumstances as the extreme limitation of the food supply or the complex anxieties of occidental middle-class life may diminish the ratio of increase even below unity, but it is important to note that starvation will diminish man's happiness long before it diminishes his health, and that his general health is affected before there is any appreciable diminution in his procreative power. He will thus, in most cases, struggle to increase his supplies long before he begins to diminish his reproductive activities. If, in such a case, there is an available organizational structure, such as is provided by the national units, this structure will be used as a rallying point in the struggle and will itself take on the characteristics of a self-maximating entity.

This vicious circle, pointed out by Malthus, is however by no means the only and probably not even the immediate root of the self-maximating tendencies of national units. Not only the whole population but also the separate individuals or small aggregations of individuals may be self-maximating. Considering man simply as a mammal, we could not predict this, because our merely mammalian needs are satiable. The individual mammal needs oxygen, food, water, sleep, sexual satisfaction, etc. but each of these needs is limited by the animal's physiological capacity and by the time at its disposal. It cannot consume more than a certain amount of any of these commodities in the twenty-four hours. Man, however, has become conditioned in most (but not all) of the cultures of the world to desire certain other things and to desire these with what appears to be infinite appetite. Necessarily the commodities so desired are non-physiological and such that the time spent on their enjoyment is not proportionate to the amount of the commodity enjoyed. To admire oneself, to be admired, to be obeyed, to be feared, even to be hated—these can be enjoyed with minimum consumption of time, and many of us in many cultures have acquired insatiable appetites for one or more of these "goods". These appetites, in turn, may often take on a crudely economic form because real goods are instrumental to their satisfaction. It is, however, very important to remember that these insatiable needs, even when they take on an economic form, are not simple expressions of mammalian nature but are based upon acquired appetites the derivation of which is a social and psychological problem, not a problem of economics.

That these insatiable appetites, once implanted, should affect the policy of the national unit and contribute to it the characteristics of insatiability is not surprising, though much detailed analysis is still needed to map the exact causal routes through which this occurs in each national unit with its specific system of personal incentives and "values". It is, however, worth noting that in those cultures which build up the group or the national unit to be a symbol of the disciplining parent —i.e. confer upon the national symbol some of the authority of conscience— the participating individual is *ipso facto* made free from almost all ethical limitations when he avails himself of the instrumentality of the group or nation in the pursuit of his own insatiable desires. And also we may note that the individuals feel that they themselves share in the authority and prestige which is imagined to be acquired by the national unit.

As to how these insatiable appetites are implanted in the individuals, we have as yet very poor information—none, I believe, which is sufficiently exact to enable us to answer questions about the differences which undoubtedly exist between one occidental culture and another. We know enough, however, to say that the appetites themselves are complex and varied, and that they are largely determined during early childhood. Here only two of the outstanding patterns will be mentioned.

a. In a very large number of cases the appetite for power or prestige is founded upon a need for psychological security and reassurance which goes back to early childhood experience. Prestige and/or power are seen as instrumental to security but, in reality, acquisition of these instruments brings at most only a taste of the longed for security. The individual may for a little while achieve something like security at a given level of the social system but, having achieved this, he moves up the ladder and arrives at a status for which he may be unfitted and in which he meets his old insecurity in an even more urgent form. The individual is thus kept striving endlessly and neurotically for instruments which can be acquired but which do not accomplish their purposes.

b. In a great many cases, the individual is conditioned to value not a *state* of power or prestige, but an *increase*. A mechanism designed to perceive the direction of a change need only give "*plus*" or "*minus*" answers and therefore is always simpler than the mechanism required to measure a steady state. This generalization applies with even greater force to human perception owing to such phenomena as visual accommodation and olfactory "fatigue", and undoubtedly it applies also to our perception of more complex stimuli. Thus our seeking for power or prestige or security is often not a mere seeking for a certain status but rather a seeking for an upward change in status. Only on an actual upward gradient can we be sure that we are not going down; a steady state we are unable—or too lazy—to estimate with sufficient sureness to relieve our anxieties. Now, there are many societies in the world which present a very different picture, societies in which change of status is limited by the character structure of the individuals who learned in childhood to feel not less but more anxiety when they perceive that their status is shifting towards the unfamiliar. We often express our disapproval of such so-

cieties, labelling them as "static". We, ourselves, however, show extreme anxiety when there is any suggestion of altering the structure of the social ladder. The changes in our own status which result from our own climbing may give us a taste of reassurance, but the total system within which we climb must, by all means, remain static. And the phenomena of nationalism are an integral part of that total system. The national unit itself is an instrumentality by which we achieve a semblance of prestige, security and power and to which, by using it, we transfer our own insatiabilities.

STEPS TOWARDS DIMINUTION OF NATIONALISM

From this broad analysis, we may draw certain conclusions relevant to nationalism in an atomic age:

1. It is evident that the insatiability of national units, so long as these remain separate, can be mitigated only by a very drastic revision of incentives and values at an individual level within each nation. We first become susceptible to these incentives and build an appreciation of these values into our characters at an early age. To alter future generations so that they may not be similarly prone to seek neurotically for instruments which promise but do not confer security, will require a careful readjustment of the character-forming contexts of childhood. But we ourselves, though we may agree that such basic changes are necessary, can scarcely execute them. We, after all, have been conditioned to accept the major premises of our own competitive and anxious culture and this acceptance is implicit in our tone of voice whenever we comment favorably or unfavorably upon our children's acts and whenever we try to influence their behavior. We are caught in a hen-egg system, but anthropology can at least offer this much comfort—it can assure us that our problem is more soluble than that of the hen. The color of her chicks is determined by her genes and those of some cock, whereas the character of our children is in large measure determined by environmental experience.

2. There are also, a number of steps which could be taken to modify incentives among adults, and some hope that these modifications might be built into the culture which is transmitted to the children. Essentially it is a matter of making each individual maximally proud to do well that for which he is most fitted, ensuring that he shall have a chance at some occupation for which he is fitted and preventing him from being promoted to some other job because he happens to do well where he is. The psychological techniques for the assessment of character and skill are today good enough to save government and industry millions of dollars by the prevention of square pegs in round holes and these techniques will no doubt profoundly alter our patterns of incentive. The same techniques could also be used to intercept the more neurotic individuals before they reach the policy-making positions which, inevitably, they seek.

3. It is clear that every national unit should have an agency which will continuously evaluate social changes, examining them for their psychological and economic implications. Such an agency would see each institution and each new trend and major context of life as a character-forming context. It would ask: What are the effects of this institution going to be? What experiences will the participating individuals meet in their dealings with this institution? And how will these experiences affect their character and future behavior? Mass communications, civilian food habits and life in the armed services were subjected to this sort of analysis during the war, and no doubt in time we shall do this sort of thing for every important element of the culture—from baby carriages to the impact of commercial advertising. It is essential that our mammoth communities be so structured that they, by means of their governments, have optimum facilities for adaptive behavior.

4. At a later stage it will be necessary to solve the problem of those national insatiabilities which are derived from population growth. For this undertaking we probably have time in hand and can afford slowly to build up the necessary world climate of opinion, insights and incentive systems. For the present it is clear that none of the three major powers in the world is motivated toward conflict by pressure of population and it appears that the recurrent famines of the world are due more to deficiencies in distribution than to a permanent world shortage. It is possible also that industrial applications of atomic energy may further postpone the pinch of population pressure.

ESTABLISHING A STABLE WORLD ORGANIZATION

As anthropologists we know that small human communities can exist without a centralized authority. There is, however, a very clear limit to the size of such communities. Even with a food supply which will permit large aggregations of people and with enemies in the offing (always a great help to social integration), the chiefless communities of New Guinea can only hold together about one thousand individuals. Above this size, the community will split, one half going off and starting a new settlement. And today with the prohibition of headhunting and resulting lack of fear, communities even as small as three hundred are liable to split. Also, specific constructive activities may be used to integrate rather large numbers of people. Among some of the American Indian tribes it was possible to integrate for a short period of time as many as two thousand individuals around such undertakings as the buffalo hunt.

For the integration of larger aggregates, we know that a centralized coordinating agency is necessary and we know a good deal about the conditions which must be fulfilled if such an agency is to maintain its effective status. By extension, we may be sure that the stability of any central agency which will coordinate the various national subdivisions of the world will be subject to analogous conditions. Therefore it is worthwhile to examine the various types of central mechanism which exist in various types of human community in order to obtain insight into these conditions.

At the outset, we can say at once that all such central coordinating agencies must have *multiple* functions. We may be tempted to guess that in their origin these various types of leaders, coordinating committees, religious officials and so forth were established to meet some single recognized need, such as the organization of war, the enhancement of popular vanity, the entertainment of the people, the petty advantage of the leaders or of some specific faction, the making or the enforcement of law, or the organization of food getting. But, however this may be, the fact remains that all stable coordinating agencies in existing societies have actually multiple functions. Their relationship to the people can be analyzed as a complex give-and-take of services, such that the chieftain or committee is a real organic part of the community.

This great complex of acts is also a system of *communications*—it constitutes for all the individuals concerned a stream of experience such that they consciously or unconsciously absorb the major premises and attitudes upon which the stability of the whole system depends. Our own election system, for example, is a series of acts whereby the elected candidate is made dependent upon the electorate but it is also for the electorate not only a source of entertainment but also an advertising of the importance of government. Candidates A and B may criticise each other as much as they please so long as the basic premise upon which their structures are based is the importance and seriousness of government. Even the electoral process serves multiple functions.

We are today faced with a single major need—for the elimination of war between national units—and we therefore attempt baldly to construct a central organization which will do this and, almost, this alone. We argue that "it must have teeth" and we see our dreamed of structure as functionally analogous to a police force—not as analogous to a government. The anthropologist sees at once that such a structure will not be able to maintain itself.

It will not establish a give-and-take of services and communications such that the participant individuals will learn to live in terms of the major premise that there is a world organization of which all are part.

It is therefore essential that the world authority shall be implemented with multiple functions so contrived that a maximum number of individuals all over the world shall be brought into the orbit of activity in reference to it and from such activity shall learn and appreciate its importance. That it should have large scale propagandic and educational functions goes without saying—a budget about equal to our expenditure on atomic development would be a reasonable beginning—but beyond this it should be able to build up its prestige with the multitudinous devices that every government uses to demonstrate that all have a vested interest in its continuance and success, devices ranging from flags and parades to postal services and epidemic control. It, and not the national units, should pay the salaries of the delegates to its assemblies, and we may begin to feel hopeful when its civilian employees run into the hundreds of thousands, all of them with a vested interest in its continuance. In this connection, it is clearly very desirable that many agencies like the proposed Atomic Development Authority be set up under the central aegis.

It is also important to consider the order in which various types of function shall be vested in the world authority. If we thing merely in terms of police power, there is a danger that we may assign to the agency this function before it has received those other powers which are necessary to enable it to maintain itself. We know that with only police power no such agency can be stable. Even on a small intra-national scale, purely police organizations become so unpopular as to be unable to maintain themselves and it is exceedingly unlikely that, once having police power and incurring the resulting odium, the world authority would be given those additional powers which it needs in order to live. On the other hand, once having the power to make its continuance desired, the world authority could easily convince the national units that the other terms of the charter should be implemented by addition of police power. Not only the final structure but also the steps of it sevolution must conform to the conditions which limit its stability.

In conclusion, let me emphasize again that these problems are susceptible to anthropological and other types of scientific analysis; that *only* by awareness of the circumstances and processes involved can we be influenced towards adaptive courses in the short span of time at our disposal. The penalty for failure to accomplish the necessary analyses or for failure to make our conclusions available to the peoples and policy-makers of the world is vast. It is the spread of destruction, famine, disease and chaos to the whole human species. It is the sudden plunge from organized life into social entropy. In the past, with groping awareness, man has slowly evolved complex and highly differentiated social systems. When his awareness of the effects of his own acts was insufficient, a single tribe or a single empire has rotted away but other cultures and communities have survived. Today we face the possibility that the whole result of this long evolution may be destroyed. Today also, we are beginning to achieve higher orders of awareness, more rapid and more critical techniques for analyzing social processes. Insofar as our awareness is improved, it is possible—but not certain—that we may be able to plan and carry out those steps which will save us all.

Gregory Bateson is an important British-American anthropologist. He is at present the Secretary of the Institute for Intercultural Studies.

Clinton Laboratories Training Program

The Clinton Laboratories, which are operated by the Monsanto Chemical Company under contract with the Manhattan District, are planning to conduct a combined training and research program during the fiscal year 1946-47. The purpose of this program is to aid in the dissemination of information, both fundamental and applied, concerning chain reacting piles and their uses for both science and engineering. The facilities of the Laboratories will be made available to about 35 highly trained scientists and engineers from academic and industrial laboratories who have not had previous experience with piles. Those selected will have an opportunity to attend a coordinated lecture program on the theory and operation of piles and to participate in the research and development program of the Laboratories. This program includes the following two broad fields:

A. Fundamental Research in the Fields of Nuclear Physics and Chemistry. This research will involve both theoretical and experimental work.

B. Design of Piles. This program has as its principal objective the extension of the technology of pile development into the important fields of peacetime application.

The key administrative staff of the Clinton Laboratories is as follows:

Research Director: Professor E. P. Wigner. (On leave from Princeton University.)

Director of Physics Division: Dr. L. W. Nordheim.

Director of Chemistry Division: Dr. J. R. Coe.

Director of Technical Division: Dr. M. C. Leverett.

Director of Power Pile Division: Dr. C. R. McCullough.

Director of Training Program: Dr. Frederick Seitz.
(On part-time leave from the Carnegie Institute of Technology.)

The Research Divisions of the Laboratories have full-time staffs engaged in the activities of the Laboratories. These staffs include scientists and engineers who have been involved in nucleonics for a number of years. The participants of the training program are expected to work in close cooperation with the full-time staff in order that the Laboratories may function as a well-coordinated unit. Assignments will be made primarily on the basis of the interests of the participants; however, the interests of the Laboratories must also be kept in view.

The training program will begin July 1, 1946, and extend for the entire fiscal year. The formal lectures will not begin until about September 1, 1946.

The lectures will be given by a select group of physicists, chemists, and engineers. The major portion of these will be chosen from the Laboratories' staff, but a substantial fraction will be visiting scientists and engineers who have had extensive experience in the field of nuclear science and engineering. The topics of the lectures will be chosen from the following fields:

A. Fundamental Nuclear Physics.
B. Pile Science (Theory and Operation).
C. Radiochemistry.
D. Engineering Design of Piles.

The Clinton Laboratories will request living accommodations in Oak Ridge for the participants. These accommodations consist of individual houses, apartments, or dormitory rooms, depending upon individual needs, in the town of Oak Ridge, which is a fully equipped modern community. Transportation is available from Oak Ridge to the Clinton Laboratories. Requests for housing will be handled by Dr. Prescott Sandidge (Address: Box 1991, Knoxville, Tennessee). Moving expenses can be arranged.

All participants will be transferred to the payroll of the Clinton Laboratories. Questions concerning salaries will be referred to Dr. Prescott Sandidge. In general a no-gain, no-loss policy will be adopted.

Applications for participation should be made to Dr. Frederick Seitz, Department of Physics, Carnegie Institute of Technology, Pittsburgh 13, Pennsylvania.

A Compromise Suggestion by the British Association of Scientific Workers

The "Scientific Worker," the organ of the British Association of Scientific Workers, in its issue of August, 1946, discusses the reasons wh the "Baruch plan has not been accepted by USSR." The commentator sees three such reasons: (1) The suggestion for the abolition of the "veto," which the USSR considers its only protection against the UN being used by USA and Great Britain to enforce their will on the Soviet Union; (2) the supranational nature of the proposed Atomic Development Authority, which would give this organization a marked economic (and, hence, political) influence and may be used to undermine the socialist planned economy in the USSR; and (3) the method of proceeding in stages, which (as the commentator sees it) "would mean that the present monopoly possessed by the USA in bomb manufacture would be strengthened in all the early stages by tying the hands of other nations and preventing them exploiting their own natural resources of the raw materials."*

The "Scientific Worker" then asserts that "doubts whether the USSR would agree to any scheme of international inspection in any circumstances appears to be unfounded" and proceeds to outline a proposal which it thinks "it should be the task of Great Britain to present" "to effect a compromise between the two points of view. Such a compromise should be based on the following points, which could well be discussed as a basic policy for the A.Sc.W. on the international control of atomic energy.

(1) An effective international Control Authority should be instituted with provision for effective safeguards by way of inspection to protect complying states against the hazards of violation and evasion.

(2) The control should be vested in the hands of an Atomic Development Authority. The complying nations should covenant to allow officers of the Authority access for inspection purposes to all mines and other sources of necessary raw material and all plants producing fissionable material and to provide the said officers with facilities for satisfying themselves about the amount of fissionable material being produced and that none is being set aside for military purposes.

The Atomic Development Authority would also sponsor research and development in all matters concerned with atomic energy, and should put the knowledge available at the disposal of all the complying nations for the peaceful development of atomic energy.

The plants in which the atomic energy or fissionable material is produced should be operated by the nation in whose territory they are situated and the atomic energy, fissionable material and all by-products should be the property of the said nation.

The officers of the Authority should be subject to the laws of the nation concerned, provided these laws are not in contradiction to the obligations entered into of all nations in connection with this atomic energy control scheme.

(3) The Atomic Development Authority should be subject to the direction of the Security Council which would be the body responsible for dealing with violations and evasions.

(4) The ordinary rules of procedure of the Security Council, including the unanimity rule, should apply to questions of violations of the control agreement.

(5) The complying nations should enter into a solemn covenant never to use atomic energy for warlike purposes.

All existing stocks of atomic bombs should be dismantled and the fissionable material contained in them put to peaceful Industrial use.

No further atomic bombs should be produced.

(6) The international control to be implemented by stages. The various stages to be accompanied by a progressive easing of the secrecy provisions, starting with the release of all fundamental scientific data in the first stage.

The subordination of the ADA to the Security Council, the retention of the existing voting procedure, the immediate outlawing of the atomic bomb and destruction of existing stocks, are the by now familiar suggestions for the conciliation of the American and Soviet points of view. It is noteworthy that as an additional suggestion, the "Scientific Worker" proposes the return from the Lilienthal-Acheson plan of international ownership (or management) of "dangerous" atomic energy installations, to the earlier plans of national ownership and international inspection-proposals which many felt would be particularly difficult for the Soviet Government to accept, because of the large amount of "snooping" by inspection agents they would imply.

* For a criticism of this and similar interpretations of the American plan, see editorial of this issue.

Editorial–

(Continued from page 1)

tious plan of international cooperation envisaged by the Lilienthal board. Other countries, too, may need time for the evolution of their thinking.

* * *

The signing of the Report of the Scientific and Technical Subcommittee (reprinted in this issue) may perhaps be the first step in such an evolution. The contents of this report may appear trivial to Americans, but its unanimous adoption is nevertheless not unimportant. It signifies the consent of the Soviet delegation to base its future attitude on the same set of scientific and technological facts which have dictated the development of our own thinking in the last year. One point in particular, has now become common ground—the close relation between the development of atomic energy for peaceful purposes, and the fabrication of atomic weapons. We recall that outlawing of bombs without interference with the national fabrication of atomic "fuels" for industrial purposes has been one of the main features of the "Gromyko plan."

E.R.

Security Through the Sacrifice of Sovereignty

. . . . . *Chester I. Barnard*

The following is from a speech delivered by Mr. Barnard at Controlled Institute of America on September 16. After outlining the known facts about the Atomic Bomb and the proposals made for the International control of Atomic Energy. Mr. Barnard proceeded as follows:

There are those who seem to believe that we should be able to attain the international control of atomic energy without paying for it and who think that particularly the United States and perhaps Great Britain and Canada, who were our partners in the development of the atomic bomb, should be able to do so without giving up anything except the right to use the atomic bomb. There are others who think we should relinquish nothing of the preferred position we have in the immediate present except under conditions that would absolutely guarantee that no other nation should be able to develop atomic bombs in sufficient numbers to be dangerous. These attitudes seem to me to be quite unrealistic and dangerous. I see no possibility of establishing any means that would give such absolute guarantees, nor do I see the possibility of achieving any plan which does not require us to give up something more than the bomb itself. We dare not relinquish our present position except under conditions which insure the possibility of adequate inspection and control and we cannot ask that of other nations without ourselves also submitting to the same conditions. This means that we and all other nations would have to part with a small part of that thing called national sovereignty to the extent necessary to control the bomb in the interests of all. Those who object to doing this seem to me to make as their objective that we shall win the wars in which we may become engaged and nothing more. Let us assume that we shall always win our wars. It will still remain, I think, that the winner in modern war will also lose. The destruction which the wars of the future will impose on winner and loser alike is likely to make the question of who wins of little consequence. More than all, I think those who take this independent and isolationist position do not sufficiently envisage the peacetime consequences of failure to establish international control of atomic energy.

Let me close, then, with a broad picture of what I think those consequences are. If, unhappily, we should definitely discover that it is impossible to secure a workable international agreement for the control of atomic energy, we shall begin with increasing energy to speculate on whether or how soon other nations will have the secret and will be engaged in the production of atomic explosives. It will not be long before we shall first fear and then be certain that other nations have this means of destruction. By that time we shall be certain that though there is no defense against the atomic bomb, it is at least possible for us to reduce our vulnerability. The concentration of our population and our industries in large cities and in vast manufacturing plants is the condition of maximum vulnerability not only to atomic bombs but to other types of bombs as well. The reduction of that dangerous condition calls for the dispersion of both our industrial plants and our population. If that were to be done quickly—say in 10 or 20 years—the cost would be so great as to reduce our standard of living to an extremely low level and even the beginning of an attempt to do so would so affect the structure of urban real estate values as well as those of industrial plants as to shatter the entire economy of the country. The drastic destruction of the values of both residential and other properties and the extreme opposition to the forced dispersion of populations all seem to me impossible of accomplishment except under a scheme of regimentation that would be nothing less than totalitarian government. Before such a redistribution of our industrial resources could be accomplished and even after that, we should be subjected to a life of perennial fear; and the burdens of constant preparations for defense on a scale of which we have no experience in this country in peace times would be our perpetual lot.

The perennial fear of impending destruction to which I have referred is probably more deadly to our civilization than even the immense burden of taxation which constant preparation for defense against atomic warfare would impose. The British having a more concentrated urban civilization than we, and having already experienced the immense damage of aerial bombing, are more realistic about this aspect of atomic armament than we are likely to be. Lest you think I am scare-mongering merely to vent my personal opinions, I should like to quote from a recent report on "The Era of Atomic Power" by a Commission appointed by the British Council of Churches, as follows:

"It is not easy to contemplate the nature of our lives if the political attempts to find methods of international control prove fruitless, and thus a state of tension were to arise comparable to that which existed in the years before the war which has just ended. But we can turn our minds back to the years between 1935 and 1939 and consider what they would have been like if the atomic bomb had already been invented. Even then, with a far less probable prospect of less complete destruction "and disorganization, it was clear that European civilization could not long endure the uncertainty created by the constant danger of war. The mere discovery of the atomic bomb itself, even if it is never used, might well create such strains in our society as to destroy it. If human experience counts for anything we can only conclude that in such a state of insecurity most men and women would be forced back into a life that accepted impermanence as something inevitable, and would live only for the present. No more powerful solvent of any society can be imagined than the general acceptance of this view. It would be blindness to ignore the presence already in the minds of many young men and women of a feeling in some ways akin to such despair, a belief that for them political action is futile, for they are helpless in the grip of forces quite beyond their control."

When I first heard the news of the bombing of Hiroshima, I said: "There goes the freedom of the American people." I have since been more optimistic, having seen the possibility of a realistic plan of the international control of this means of destruction. Whether that plan can be realized depends not only upon ourselves but upon the peoples or the governments of other nations. If they will not accept such a plan, we are helpless; but if they will, it still remains for us also to accept the plan and to pay our part of the price that all must pay to make it work. Though there are dangers that no plan would work indefinitely, it seems to me certain that the consequences of failure to secure the adoption of such a plan are the destruction of the ways and means of American democratic life.

Memorandum to the President . . . . Cont.

(b) **The Facts**

The Soviet proposal, as presented to the Commission by Ambassador Gromyko on June 19, calls for a mere agreement to prohibit the production and use of atomic weapons and to destroy any stocks of atomic weapons within three months from ratification. The agreement would include a declaration "that any violation . . . is a serious international crime against humanity." It would also require the signatory nations to enact national legislation providing severe penalties for violators.

The Soviet proposal as thus far presented does not go further than the U. S. plan. Nor does the Soviet proposal in fact make violation of the proposed treaty "a national and international crime for which individuals can be punished."

The U. S. Delegation has hoped that upon exploration of the Soviet plan it would be found to contemplate creation of machinery for holding violators (particularly officials of a wrongdoing government or, if possible, such a government itself) accountable before an international tribunal and for punishing them.

Repeated efforts to elicit from the Soviet representative reassurances on this point have thus far proved fruitless. So far as we have been able to determine from the statements of the Soviet representative, the Soviet proposal to declare violation "a serious international crime" is not accompanied by any machinery for enforcement other than an appeal to the Security Council, with the veto intact to serve as a possible shield to the violator. The proposal for national legislation might prevent misuse of atomic energy by private individuals within a country, but it would of course have no effect on the national governments themselves. Moreover, the Soviet proposal contains no suggestions for international preventive control measures as contrasted with punishment after an offense. Obviously, prevention is the essence of control.

5. **REFUSAL BY UNITED STATES TO MODIFY THE PRINCIPLES OF ITS PLAN**

Secretary Wallace states at several points that he believes the Russians would negotiate a workable agreement if the United States were willing to modify its plan so as to make it more acceptable. Thus he says:

> "We may feel very self-righteous if we refuse to budge on our plan and the Russians refuse to accept it, but that means only one thing—the atomic armament race is on in deadly earnest."

And again:

> "We must be prepared to reach an agreement which will commit us to disclosing information and destroying our bombs at a specified time or in terms of specified actions by other countries, rather than at our unfettered discretion. If we are willing to negotiate on this basis, I believe the Russians will also negotiate seriously with a view to reaching an agreement."

And finally:

> "The Russian counter-proposal itself is an indication that they may be willing to negotiate seriously if we are."

The United States delegation cannot consider modifications in those fundamental principles of its plan which, in our judgment, must be maintained to meet the mandate given the Commission by the United Nations General Assembly last January. We have repeatedly encouraged the presentation of any other proposals which would meet this mandate. In particular, we have indicated that we would welcome any suggestions to strengthen the proposed controls. And we have always displayed readiness to negotiate details in collaboration with all the other delegates as long as the details fit within the proper framework of principle. We have insisted only that the Commission abide by its instructions, which require it to "make specific proposals . . .

> "(b) for control of atomic energy to the extent necessary to ensure its use only for peaceful purposes;—
>
> "(d) for effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions."

These instructions were subscribed to by the Soviet Union, the United Kingdom, and ourselves at the Moscow Conference of Foreign Ministers last December and were unanimously endorsed by the General Assembly of the United Nations on January 24, 1946. Any modification which achieved agreement, but failed to provide effective control and safeguards to prevent the misuse of atomic energy and to give timely warning of violations, would merely create a false sense of security. Such an agreement would be directly contrary to the specific and unanimous instructions of the United Nations. It would be a fraud on the peoples of the world.

(Signed) Bernard M. Baruch

Documents released by Mr. Baruch reveal that Mr. Wallace and Mr. Baruch met on September 27 to discuss the Wallace letter. At this meeting, Mr. Wallace, when confronted with the details contained in the Baruch memorandum, admitted that he "had not been fully posted on the facts."

It appears that Mr. Wallace first agreed to a statement (satisfactory to Mr. Baruch) in which he (a) stated that he was impressed by the reasonableness and sincerity exhibited by the United States atomic energy delegates in their negotiations, (b) admitted that his information concerning Baruch's proposals had been in error, and (c) emphasized his agreement with Baruch on the importance of the following points: (1) Any plan of atomic energy control, although it must involve a series of steps or stages in achievement, must be agreed to in advance by all parties. (2) The specific sequence and substance of the stages to be incorporated in the treaty shall be freely negotiated and specifically and clearly laid down. (3) The machinery of atomic energy control shall contain adequate inspection and other safeguards, and shall contain no loopholes whereby any nation, large or small, could threaten the peace of the world and at the same time prevent concerted action to maintain the peace. (4) Satisfactory agreement on international atomic energy control is dependent on the development of mutual faith and confidence among the nations.

Instead of signing this, Mr. Wallace on September 30 proposed an alternative statement (unacceptable to Mr. Baruch) in which he omitted both his admission of factual error and his express approval of Mr. Baruch's course of negotiations. Mr. Baruch has pointed out that these omissions "were gravely dangerous to the delicate negotiations now under way. They create confusion and division among our people." (We refer our readers to the **New York Times** of October 3.

We quote from the alternative Wallace statement merely because it presents Mr. Wallace's position at the present writing. (The question of Mr. Wallace's error and their consequences is adequately dealt with in the Baruch memorandum.): "There still remains the central issue for which my letter was directed but which received no mention in Mr. Baruch's memorandum. The present impasse of the negotiations for atomic energy arises from two basic points of disagreement. The first and most important one relates to the question of whether the United States should continue its production of stockpiling of atomic bombs during the period of transition before international control. The second relates to the Russian refusal to agree to an international system of inspection to control atomic energy production so as to assure peaceful use. The serious point of disagreement on which to work is that the United States Atomic Energy Commission has been deadlocked for some time and serves to demonstrate the major thesis of my letter to the President—the absence of an attitude of mutual trust and confidence between the United States and Russia."

BULLETIN of the
ATOMIC SCIENTISTS
1126 E. 59 St.
Chicago 37, Ill.

Sec. 562, P.L.&R.
U. S. POSTAGE
PAID
Chicago, Ill.
Permit No. 6426

NOTES ON CONTRIBUTORS

CHESTER I. BARNARD, *President of the New Jersey Bell Telephone Co., was a member of the State Department Board of Consultants which wrote the "Acheson-Lilienthal" Report.*

GREGORY BATESON, *the Anglo-American anthropologist, is now on a Guggenheim Fellowship.*

LEW KOWARSKI, *one of the French pioneers in fission research, was a leader on the English and Canadian atomic bomb projects. He is now Scientific Director of the French Atomic Energy Authority.*

DAVID E. LILIENTHAL, *Director of the Tennessee Valley Authority, was Chairman of the State Department Board of Consultants on Atomic energy.*

GEORGE W. MERCK, *President of Merck Co., the chemical firm, was in charge of the U.S. wartime research on biological warfare. The article in this issue represents the principal official release on this subject to date.*

C.P. RHOADS *is Director of the Sloan-Kettering Institute for Cancer Research, Director of the Memorial Hospital and Chairman of the Committee on Growth, National Research Council. The article in this issue is from a talk given before the Scientific and Technical Committee of the UN Atomic Energy Commission and was issued by the Baruch office.*

BERTRAND RUSSELL *is one of the great living philosophers.*

PUBLICATIONS OF THE BARUCH OFFICE

The office of the American delegation to the UN Atomic Energy Commission has issued so far four volumes of publications entitled "Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Representative."

Volume 1, issued on June 14, contains a preface by R. C. Tolman and seven articles on Atomic Energy (Bacher and Feynman), Production of U235 and Pu (Nichols and Ruhoff), Military Effectiveness of the Atomic Bomb (Solomon and Morrison), on the Radioisotopes in Research (W. Cohn), Therapeutic Uses (Rhoads and Solomon), Medical Applications (Stone and Hamilton), and Biological Warfare (Merck, Fred, Baldwin, and Sarles).

Volume 2, issued on July 10, contains a preface by J. R. Oppenheimer, and articles on Future of Atomic Energy (Compton and Jeffries), High Energy Physics (Lawrence), Radiation Chemistry (Franck and Burton), and the Gaseous Diffusion Process (Urey and Williams).

Volume 3 (August 15) contains a bibliography of articles on atomic energy and nuclear physics published in US after August, 1945.

Volume 4 (September 5) contains a short article on nuclear power, by a group of scientists from the Clinton Laboratories at Oak Ridge.

The present issue constitutes a double number—Volume 2, Nos. 7 and 8. The price of a single copy of this issue is 20c.

The opinions expressed in the editorials and other articles printed in the Bulletin do not necessarily represent the official views of any organization.

Material in this Bulletin is released for publication at 12 noon. Saturday, October 12.

BULLETIN OF THE ATOMIC SCIENTISTS

EDITORS:
H. H. Goldsmith E. Rabinowitch

The Bulletin is published twice a month by The Atomic Scientists of Chicago, 1126 E. 59 St., Chicago 37, Ill.; Subscription price—$1 for 6 months; $2 a year. Special rates for groups. Manuscripts should be sent to H. H. Goldsmith at the above address.